SIDE-DIVERSION ANALYSIS SYSTEM

by

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The project was conducted at the Center for Research in Water Resources of the University of Texas at Austin. Part of the project work is reported in "Physical Modeling for Side-Channel Weirs" by K.-L. Lee and E. R. Holley (2001). That report presents the results of studies conducted in a physical model to investigate the hydraulics of side-channel weirs and side diversion culverts.

SIDE-DIVERSION ANALYSIS SYSTEM

1 - INTRODUCTION

In a previous project conducted at the Center for Research in Water Resources (CRWR) and sponsored by the Harris County Flood Control District (HCFCD), experiments were conducted (Tynes, 1989) to determine the hydraulic characteristics of embankment-shaped side weirs, and a computational method (Davis and Holley, 1988) was developed for designing side-channel weirs. The computational method used manual iteration between HEC-1, HEC-2, and a new program, SIDEHYDR, which was developed specifically for the task of modeling flow in the channel beside a side weir, flow over side weirs, and the filling and emptying of a detention basin.

The present project built directly on the work done in the previous project. The objectives of the present project were as follows:

1) Develop a computer program to automatically perform the iterations between the programs HEC-1, HEC-2, and SIDEHYDR for the design of side-channel diversion weirs;
2) Add "pop-up" screens for input and for graphical display of the results of the iterations on the computer monitor;
3) Identify the source of computational oscillations in the computer program SIDEHYDR and change the program to remove the oscillations;
4) Prepare a user’s manual for the entire computational package of programs, including an improved treatment of the potential pitfalls and error messages in the SIDEHYDR program;
5) Expand the SIDEHYDR program to calculate culvert drainage of water stored in the detention basin below the weir crest;
6) Modify the SIDEHYDR program to allow the choice of either side weirs or culverts for flow diversion;
7) Conduct hydraulic model experiments to evaluate the effects of channel side slopes on side weir hydraulics;
8) Modify the existing side weir physical model and conduct experiments to determine the size and hydraulic effects of the separation zone created in the main channel by the side weir diversion flow;
9) Reanalyze data from the previous project and use computations of water surface profiles along side weirs to evaluate the potential effects of channel slope and roughness on weir hydraulics;

10) Conduct experiments to evaluate the effects of channel flow on the hydraulics of culverts used for diversion and basin drainage at detention facilities,
11) Change the method used in the computational program for flow from the channel into the detention basin based on the results from Tasks 7 and 8,
12) Extend the work of Task 8 to include channels with 4H:1V side slopes.

Only subcritical channel flows were considered in this project. Tasks 7 – 10 and 12 are all related to experimental work and are addressed in a separate report (Lee and Holley, 2001). The other tasks are related to the computational scheme and are addressed in this report.

This report presents a computational scheme for modeling side-channel weirs and side culverts used for diversion of flows into detention basins. At the sponsor's request and since this project was started in 1995, the computations use HEC-1 for rainfall-runoff calculations and HEC-2 for stream hydraulics. The previous SIDEHYDR program (Chapter 1) for the hydraulics of side diversions and for the filling and emptying of detention basins was extensively modified and renamed SIDEHYD. An automated system called the Side-Diversion Analysis System (SAS) was also developed in this project for performing the required iterative calculations using HEC-1, HEC-2, and SIDEHYD. The overall approach can be used for any geometry of channel and diversion structure. However, the current version of SIDEHYD uses the empirical results given by Lee and Holley (2001) and thus is restricted to the particular geometries that they studied.

Chapter 2 summarizes the modeling approach used in the computer programs. Chapter 3 gives the information necessary for installing and running the program. Chapter 4 gives more detailed information as an aid for making changes in the programs and the computational scheme, if desired. Program listings and sample input files are given in the appendices.

2 - DESIGN AND MODELING METHOD

This chapter presents the general approach and the computational procedures for the design and modeling method that has been developed for side diversions. The method is called the Side-Diversion Analysis System (SAS) and is based on HEC-1, HEC-2, and SIDEHYD.

2.1 - GENERAL CONSIDERATIONS

2.1.1 – Computational Approach

Although HEC-1 and HEC-2 have some capabilities for modeling diversions, neither program is flexible enough to represent some of the essential hydraulic features of side diversion flows. For example, experimental work indicates that side weir discharge coefficients vary with channel velocity and head on the weir as they change during the passage of a hydrograph, but HEC-1 and HEC-2 cannot represent these changes. Also, the programs cannot predict when submergence of side weirs or diversion culverts occurs as the basin fills, nor can they model the hydraulics of flow from the basin back to the channel as the channel water level drops. Thus, originally SIDEHYDR (Davis and Holley, 1988) and then SIDEHYD were developed.

SIDEHYD represents side diversion flows including the change in water surface elevation in the channel where the diversion is taking place, the effects of channel flow characteristics on the side diversion, possible submergence as the basin fills, the discharge characteristics for an embankment-shaped weir or diversion box culverts, and possible reverse flow over the weir or through the culverts as the channel water level drops during the recession limb of the hydrograph. The channel flow and diversion flow interact in such a way that trial and error computations are normally required to determine the side discharge and the depths in the channel (at the diversion structure, both upstream and downstream of the structure, and in the basin) when HEC-1 and HEC-2 are used. The side discharge depends on the depths in the channel, but the depths are controlled from downstream for subcritical flow and these depths depend on the discharge, which cannot be known until the side discharge is known. In addition, the depth at the downstream end of a diversion structure can depend on other diversions downstream of it, and the discharge at the upstream end of a structure depends on other upstream diversions. Because of all of these interdependencies, it is necessary to iterate between HEC-1, HEC-2, and SIDEHYDR. The procedure (Fig. 2.1) is to

1) assume diversion hydrograph(s) at the diversion structure(s),
2) run HEC-1 with the assumed diversion hydrograph(s) to obtain hydrographs in the channel,
3) use HEC-2 and the channel discharges computed by HEC-1 for times throughout the hydrograph to obtain stage hydrographs (not just the highest stages) at the diversion structure(s),

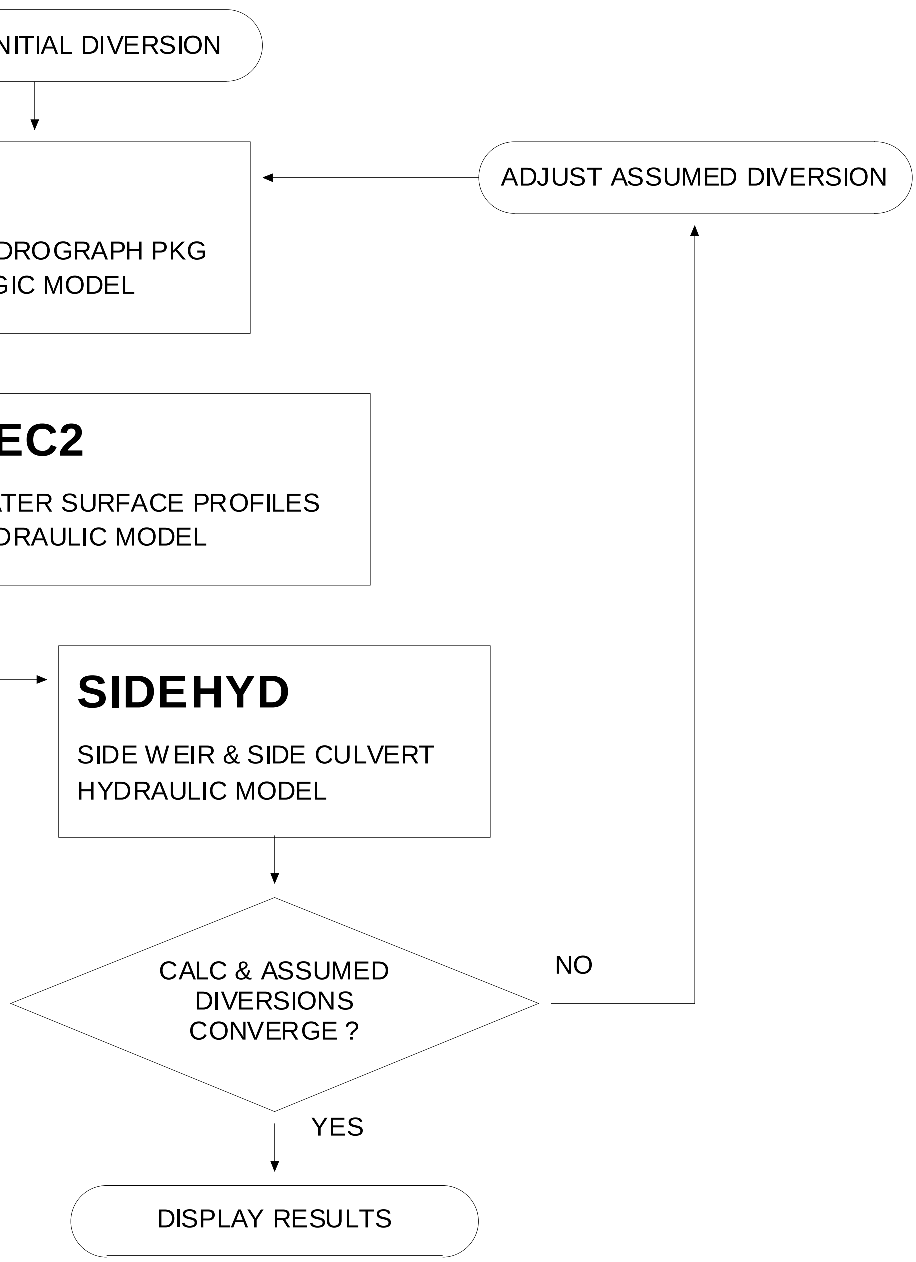


Fig. 2.1 - Flow chart for major components of SAS

4) run SIDEHYD using the channel discharge hydrographs from HEC-1, the stage hydrographs from HEC-2, and the diversion discharge characteristics from experiments to calculate the diversion hydrograph, the stage hydrograph in the basin, and the channel stage hydrograph at the upstream end of the structure,
5) for computational stability, take the new diversion hydrograph for each structure as the weighted average the diversion hydrograph just calculated by SIDEHYD and the diversion hydrograph from the beginning of the iteration cycle,

6) continue looping through steps (2) through (5) until the diversion hydrographs at the beginning and the end of an iteration loop agree within a specified tolerance.

These iterations are done automatically in SAS. The general computational scheme in SAS is applicable to side-diversion structures with any geometry. However, the program SIDEHYD presently contains empirical relationships only for trapezoidal channels with side slopes from 1:2.5 to 1:4 and for either embankment-shaped weirs or box culverts as the diversion structure. The capabilities for culverts are more limited than for weirs. SIDEHYD also includes drainage culverts for draining the water stored in the detention basin below the elevation of the weir crest or the invert of diversion culverts.

2.1.2 – Design Approach

SAS can be used to design either one or two side diversions and detention basins and to model their effects on the flow conditions in the channel. The general design calculations proceed by estimating the dimensions for each diversion facility and basin and then modeling the flow conditions in the channel, the flow through the diversion structures, and the water levels in the basins to determine if the design is acceptable. If it is not, the designs of the diversion structures and basin are modified and the new conditions are modeled. The procedure for designing and modeling the diversion structures and basins is repeated until an acceptable design is found.

When there are multiple diversion structures, hydraulic dependence between the structures may exist. Hydraulic dependence means that changes in channel water levels induced by a downstream diversion influence the channel water levels at the next upstream diversion. The drawdown induced by the downstream diversion decreases in the upstream direction. Thus, for a given set of conditions, hydraulic dependence is a function of the distance between the structures; as the distance between diversions increases, the probability of hydraulic dependence decreases. If the drawdown disappears prior to reaching the next upstream weir, the weirs are hydraulically independent. If not, the weirs are hydraulically dependent. The possibility of hydraulic dependence does not need to be addressed explicitly by the designer since it is handled automatically by SAS.

Hydraulic independence and dependence must be differentiated from hydrologic dependence. An upstream diversion may or may not be hydraulically dependent on a downstream diversion, but all downstream diversions are hydrologically dependent on any upstream diversion. Flow through upstream diversion structures will always influence the discharges at any downstream structure.

The design method can be divided into the following steps:

1) Determine general design characteristics such as channel capacity, design storm, and number of detention facilities.

2) Estimate the required basin volume for each detention facility.
3) Determine the number of basins and diversion structures per facility.
4) Estimate the dimensions for each diversion facility and the elevation of the invert of the diversion structure.
5) Using this Side-Diversion Analysis System, compute the hydrograph for each side diversion and the associated stages in the detention basin.
6) After convergence of the computations in step 5), analyze the diversion hydrographs and their effects on the channel water levels and discharges, and modify the dimensions of each structure and basin as necessary and then repeat steps 2) through 5). If no modifications are necessary, the design is complete.

Under the assumptions inherent in the HEC-1, HEC-2, and SIDEHYD programs and in the input data, this process yields properly dimensioned side diversion structures (weirs or culverts) and detention basins for keeping water levels and discharges within desired limits. However, the final design is only for the given channel and storm characteristics. If any of these characteristics are altered, the diversion structure and basin should be redesigned to account for the alteration. The design and modeling method naturally has limitations imposed by the computer programs that are used. Some of the limitations are as follows:

1) The method applies only to channels with subcritical, gradually varied flow.
2) The various discharges and water levels during hydrograph passage are represented as a series of steady states in the hydraulic computations in HEC-2.
3) The channel slope is small (less than 1:100).
4) The channel has fixed boundaries (no sediment transport, erosion, or deposition).
5) The method is longitudinally one-dimensional with friction losses computed by Manning's equation.

2.1.3 - Required General Information

Prior to implementing the design method, the items listed and explained below must first be determined.

2.1.3.1 - Design Storm

A selection must be made of the storm characteristics for which the detention facility will be designed.

2.1.3.2 - Channel and Watershed Characteristics

The input files for HEC-1 and HEC-2 must be developed to model the watershed and channel. These files do not need to include the diversions but do need station numbers related to the weirs and do need to meet some constraints on station numbering, as explained in Sections 3.3.2 and 3.3.3.

2.1.3.3 - Locations and Diversion Rates for Detention Facilities

The locations at which detention facilities are needed along the channel must be determined. Additional required information is as follows:

1) The peak discharge at the upstream end of each facility. If there are multiple diversions, this discharge for the downstream structure will need to include the effects of estimated diversions at the upstream structures.
2) The channel discharge capacity downstream of each facility based on the channel size and hydraulic characteristics. The discharge capacity downstream of the facility is the maximum discharge that will remain within channel.
3) The maximum allowable water surface elevation downstream of each facility must be determined. The peak water surface elevation in the channel can be approximated with HEC-2 using the peak channel discharges accounting for estimated diversions.

The difference between the peak upstream discharge and the downstream channel capacity is the maximum rate of diversion for the facility. Further downstream, the peak channel discharge is found from HEC-1, including the effects of inflows and storage.

2.1.3.4 - Type and Geometry of Diversion Structure

For weirs, the type of weir (e.g. sharp-crested, embankment, ogee spillway) must be selected. The weir crest shape determines the discharge coefficients that are used for the side-weir flow calculations. Of course, the coefficients that are used must be appropriate for the side-weir shape that is chosen. This Side-Diversion Analysis System presently includes discharge coefficients for only embankment-shaped weirs. If sharp-crested weirs (i.e., vertical walls with weir notches) are used for diversion, consideration should be given to possible flow-induced vibrations of the walls.

The only diversion culverts included in SAS are box culverts. The capabilities of the program for culverts are more limited than for weirs. Because of the limited size of culverts that can be represented in the modeling system, larger diversion will generally require that weirs rather than culverts be used.

2.1.4 - Approximate Required Basin Volume

The basin size needed to contain the volume of water diverted to the detention facility needs to be estimated. The volume is equivalent to the difference between the channel discharge hydrographs at the upstream and downstream ends of the diversion structure integrated over the time for which there is flow into the basin. For projects with only one diversion, the upstream hydrograph is known while the downstream hydrograph is unknown initially; thus, an estimation of the downstream hydrograph is required to obtain the volume of water which needs to be stored in a detention basin. The downstream hydrograph is most easily approximated by assuming that the diversion truncates the upstream hydrograph at the maximum allowable downstream discharge. For projects with two or more diversions, only the upstream hydrograph at the upstream structure will be known, so all of the other hydrographs need to be estimated. The Side-Diversion Analysis System provides relatively rapid calculation of the hydrographs and the required basin volume, so storage volumes can be corrected based on the calculation results.

2.1.5 - Required Number of Basins

Next, a decision needs to be made concerning the number of basins (with their respective diversion structures) required to contain the total volume of the diversion. If possible, larger basins should be located downstream of smaller basins when the diversions are hydraulically dependent. The rate of flow will generally be greater for the downstream structure compared with hydraulically dependent upstream structure, if all of the structures have the same dimensions and are the same distance above the channel invert. Since the effects of the drawdown at the downstream diversion extend to the upstream structure for hydraulically dependent diversions, the head on the downstream structure may be larger than the head at the upstream structure for hydraulically dependent structures.

The basin volume must be adequate to contain the diverted flow accounting for the fact that the maximum water level in the basin will normally be lower than the maximum channel water level at the downstream end of the diversion structure. No general guidelines are presently available for the maximum basin water level to be expected relative to the maximum channel water level. For the examples in Section 3.6, the maximum water surface elevations in the basins are about 1.7 ft. lower than the maximum water surface elevations in the channel at the downstream ends of the weirs.

2.1.6 - Multiple Diversions and Hydraulic Dependence

The Side-Diversion Analysis System can model only two diversions at a time. When there are more than two diversions along a channel, modeling should be done starting with the two most upstream diversions and proceeding downstream. However, the calculations will be correct only if the diversions modeled in a given application of SAS are hydraulically independent of the diversions farther downstream.

Checking for hydraulic dependence can be accomplished by computing the water surface profiles between the diversion structures for a given channel discharge and a range of depths at the upstream end of the downstream diversion structure. Normally the maximum discharge for the affected part of the channel should be used since the effects of the drawdown extend farther upstream for higher discharges. If the computed depth at the downstream end of the upstream structure remains constant for all depths encountered at the upstream end of the downstream structure, the diversions are hydraulically independent. Conversely, if the depth at the upstream structure is changed by a change in depth at the upstream end of the downstream structure, the diversions are close enough together that they are hydraulically dependent. HEC-2 can perform these computations with the use of an X5 record at the upstream end of the downstream structure. The X5 record allows the user to input a water level at the cross section at which the X5 record is inserted. The X5 record is placed in the input file for the location of the upstream end of the downstream structure. The exact locations of the ends of the structures may not be known since they have not been fully designed; therefore, an estimate of their locations may be required. Since depth information is desired at the downstream end of the upstream structure, cross-sectional data must be included in the HEC-2 input file for this location. Several water levels can be used on the X5 record during any single execution of HEC-2. Suggested values correspond to critical depth and larger depths up to bank-full stage.

If all depths indicate hydraulic independence, then hydraulic independence will exist for whatever the actual operating conditions are between these extremes. However, when depths near critical depth indicate hydraulic dependence, there will be some larger depths for which independent conditions will exist. Thus, it is possible that the actual operating conditions could be only at intermediate water levels for which the weirs would be independent. This possibility can be checked after some of the preliminary design calculations have been done so that estimates are available for the actual water levels at the upstream ends of the various facilities.

An example of backwater profiles for checking hydraulic independence is shown in Fig. 2.2. These profiles were calculated for an improved trapezoidal channel with a base width of 50 ft, side slopes of 3H:1V, a bed slope of 0.001, a Manning's n of 0.035, and a discharge of 15,000 cfs, which would be the discharge downstream of a diversion. For these conditions, the normal depth is 19.4 ft and critical depth is 11.2 ft. The upstream end of the downstream diversion is at a distance of 0 on the graph. If this diversion draws the depth down to critical depth, the water surface profile would be as shown by the solid line. If the diversion draws the depth down to 16 ft, then the profile would be as shown by the dotted line. If the distance between the diversions were 2000 ft to 3000 ft (distance of -2000 ft to -3000 ft on the graph), the curves show that the drawdown at the downstream structure affects the flow depth and therefore the head for the upstream diversion. The diversions would then be hydraulically dependent. On the other hand, if the diversions were separated by 5000 ft or more, the effects of the downstream diversion would have disappeared at the upstream structure, so the diversions would be hydraulically independent. (An additional curve is shown for a starting depth of 22 ft, just to illustrate that water surface profiles converge more slowly as the starting depths increase. It would not normally be expected that a diversion would cause a depth to be above normal depth or above the depth given by the slope-area method in HEC-2 using the average channel slope.)

2.2 - DESIGN PROCEDURES

2.2.1 - Weir or Culvert Dimensions

The height and length of the side weir crest are closely related. If the crest is raised, the head on the weir is reduced and the length of the weir must be increased to divert a given flow rate. The opposite is true if the crest is lowered. On the other hand, lower weirs will divert flow more frequently than higher weirs. The same trends occur when considering the invert elevation and total barrel width for diversion culverts.

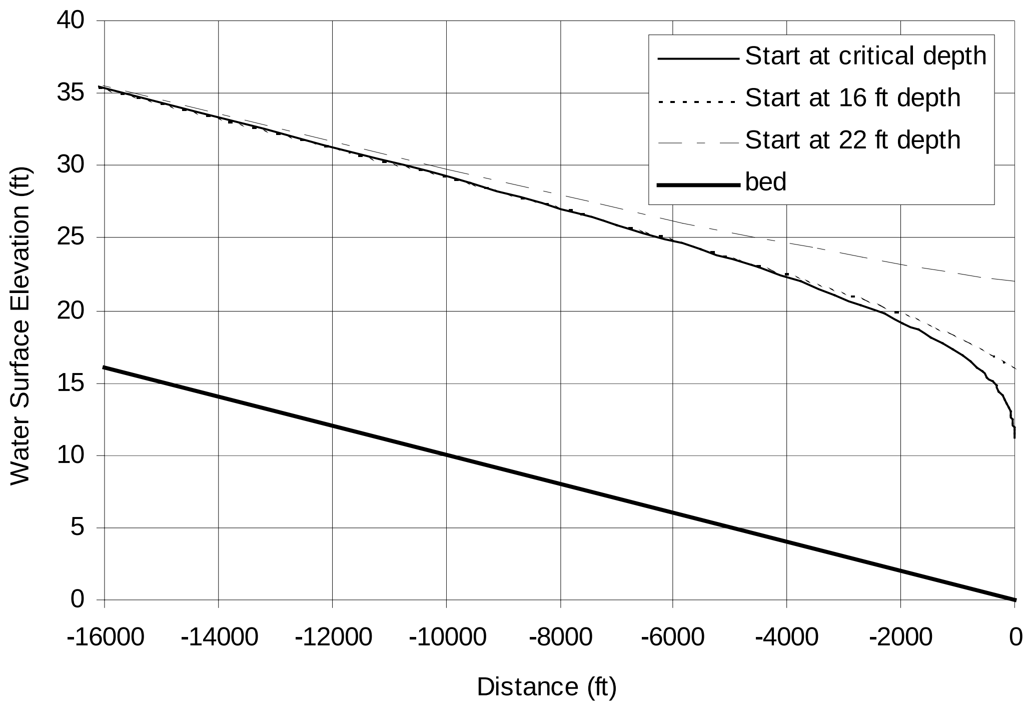


Fig. 2.2 - Backwater profiles for checking hydraulic independence of weirs

One way that an elevation for a weir crest or culvert invert can be selected is to correspond to a desired frequency of diversion of flows into the basin. The elevation can be selected to correspond to the flow depth for a storm of the desired frequency of diversion. The required weir length or culvert width for that elevation and the desired diversion can then be obtained by trial and error using SAS. If the weir is too long or the culvert too wide to be economically feasible, a lower elevation can be selected. Using the automated Side-Diversion Analysis System, calculations can be done relatively easily for several combinations of dimensions so that the best length combination can be selected.

2.2.2 - Summary of Side-Diversion Analysis System Calculations

Application of the Side-Diversion Analysis System determines the effectiveness of the diversion structure and basin design to keep channel and basin water levels within acceptable limits. If the structure is not adequate to keep the discharges and water levels within acceptable limits during a flood, then the diversion structure and/or basin dimensions can be changed.

The method used by the Side-Diversion Analysis System (SAS) is summarized below. Since the method is iterative, the steps are repeated for each iteration. The only exception is that some parts of the first iteration are different because initial approximations must be made to start the iteration process. Once the process is started, the iterations are done automatically in SAS.

2.2.2.1 - Computing Channel Discharges using HEC-1

An initial approximation of the diversion is required to begin the iteration process. The simplest approximation is that any discharge in the channel greater than the downstream maximum allowable discharge is diverted over the weir. Using this approximation, the hydrograph at the downstream end of a diversion structure is a truncated version of the hydrograph at the upstream end. This form of diversion is modeled with the Diversion Option records in HEC-1. The KK and DT records are title records. The fields of the DI record are channel discharges upstream of the structure while the fields of the DQ record are the diversion flow rates for the corresponding field of the DI record. HEC-1 uses linear interpolation to find values not given on the DI and DQ records.

After the first iteration, SAS automatically modifies the diversion records in the HEC-1 input file for the location of the side weir. For the second and subsequent iterations, the averaged diversion hydrograph from Section 2.2.2.5 below is entered into the HEC-1 input file with QI records. Negative values in the fields of the record indicate outflows from the channel while positive values indicate inflows to the channel. The QI record description in the HEC-1 User's Manual does not mention channel outflows because the record was developed to represent inflows to the channel. However, the QI inputs will work for outflows.

After the input file is prepared, the automated system executes HEC-1 to compute the discharge hydrograph at specified locations in the channel. These locations must include the downstream end of each diversion structure because the discharge hydrographs for those cross-sections are used by SIDEHYD to compute the diversion hydrograph.

2.2.2.2 - Computing Channel Water Levels using HEC-2

HEC-2 is used to compute the water level hydrographs for the channel. This calculation is done for time steps throughout the hydrograph, not just for the peak flows. SAS places channel discharge data from HEC-1 into the HEC-2 input file and then computes water surface profiles (or water surface elevations) for successive times. The discharges from hydrographs computed by HEC-1 are placed by SAS on corresponding QT records in the HEC-2 input file. Each field of the QT record represents a particular time interval. For example, the first field of each QT record might have the channel discharge for the time 15:00 hr, while the second field has the discharges for 15:30 hr and so on for each additional field. Since each water surface profile calculation by HEC-2 uses a particular field of the QT record, the profiles can be related to time. By making several profile calculations using successive QT fields, the water levels are calculated for various times, producing the water level hydrograph for the channel.

The selected times at which corresponding channel discharge data are entered on the QT records must adequately represent the channel discharge and water level hydrographs at the downstream end of the diversion structure. These representative hydrograph values are used to compute the new diversion hydrograph. There should be at least 15 to 20 hydrograph values for the time during which there is diversion flow. For the one-weir example in Section 3.6.1, there are 18 points on the graphs while there is flow in either direction over the weir for the final iteration. For the two-weir example in Section 3.6.2, the numbers are about the same. There are many more values in the SIDEHYD calculations than are shown in the figures, i.e., the time step for the SIDEHYD calculations is much smaller than indicated by the points on the graphs in Section 3.6.

Since diversion occurs only when the channel water level is above the weir crest or culvert invert, the user can input a "Threshold Discharge." This value is used by SAS to determine the point at which to begin and end the computations. The selection of an appropriate Threshold Discharge can be evaluated from the computational results of a trial run since the diversion for the first time in the simulation should be zero if the water surface in the channel is below the weir crest or diversion culvert invert. If the first diversion discharge is non-zero, the Threshold Discharge is too large and the program operation will cease. If there are a lot of initial zero values for the diversion discharge, the Threshold Discharge may be too small. The same Threshold Discharge is used for both the starting and stopping of the calculations, i.e., when the channel discharge falls below the threshold value, the computations will be stopped.

For the way that SAS is configured, HEC-2 can be used to compute up to nine water surface profiles per run. If there are more than nine time steps in the simulation, as there normally should be, SAS will execute HEC-2 multiple times.

2.2.2.3 - Side-Diversion Computations using SIDEHYD

For each pair of channel depth and discharge values for the downstream end of the diversion structure, SIDEHYD computes a corresponding diversion flow rate. SAS enters the channel water level and discharge hydrographs for the downstream end of the structure into the SIDE-

HYD input file. Negative discharges in the diversion hydrograph indicate flow out of the channel while positive values indicate flow into the channel. SIDEHYD also calculates the stage hydrograph in the detention basin.

2.2.2.4 - Drainage Culvert Calculations using SIDEHYD

SIDEHYD also calculates flow through drainage culverts. The program assumes that there are check valves on the culverts; the check valves may be either flap gates or Tideflex valves. Because of the assumption of check valves, these calculations start when the water level in the channel falls below the water level in the detention basin. The calculations for the drainage culverts use THYSYS (TxDOT, 1977) as a subroutine to SIDEHYD. THYSYS, which was obtained from TxDOT, was version 2.4.2 from January 1992.

2.2.2.5 - Averaging New and Old Side-Diversion Hydrographs

For stability in the calculations, the newly computed diversion hydrograph is averaged with the previous trial discharge hydrograph for the weir. The result is a new trial weir hydrograph to be used in the HEC-1 input file for the next iteration. Using a weighed average of the previous and current diversion hydrographs has produced stable solutions during the iterations. While stable solutions were obtained for the examples in Section 3.6, the limits for stability have not been explicitly determined.

2.2.2.6 - Testing for Convergence

The differences between the diversion hydrographs at the beginning and at the end of the iteration generally decrease during the iteration process (although there may be occasional temporary increases). As the diversion hydrographs converge, the other parameters (such as channel discharge and depth) converge as well. The calculations are considered to have converged when the differences between the diversion flow rate for each time step at the beginning and end of an iteration are all smaller than 7.5% of the maximum diversion discharge.

3 - USER'S MANUAL

3.1 - SYSTEM HARDWARE REQUIREMENTS

The Side-Diversion Analysis System is designed to run on IBM-PC compatible computers using DOS. This type of operation was dictated by the fact that SAS is built on HEC-1 and HEC-2, which are both DOS programs. Computers that use Windows as their primary operating environment must emulate DOS or exit to DOS before the system can be started. The system requires

1) an IBM-PC compatible computer.
2) a minimum of 575 KB free in conventional RAM for DOS.
3) a VGA or SVGA monitor.
4) a printer if graphs are to be printed directly from SAS. (See also Section 3.5.1.)

The software was developed primarily on a 120 MHz Dell Dimension XPS P120c computer with 16 MB of RAM, a CTX color monitor, and an HP Deskjet 660C printer.

3.2 - PROGRAM INSTALLATION

The Side-Diversion Analysis System relies on prior installation of the HEC-1 Flood Hydrograph Package and the HEC-2 Water Surface Profiles computer programs. These programs were developed by the Hydrologic Engineering Center, Corps of Engineers, Davis, California. If they are not present, it will be necessary to obtain them and properly install them. In March 2002, these program and their manuals could be downloaded from

http://www.hec.usace.army.mil/software/software_distrib/index.html

A list of vendors for the program can be obtained from

http://www.hec.usace.army.mil/software/index.html

or from

Hydrologic Engineering Center
U. S. Army Corps of Engineers
609 Second Street
Davis, CA 95616-4687
(916) 756-1104

The specific steps in the installation are as follows:

1) If it does not already exist, create a directory (folder) for the HEC executable programs at the root directory level (usually C:\HECEXE). It is imperative that the name of the directory be in the PATH statement of the DOS environment so that the programs can be executed from any directory without use of their complete path.

2) On the C:\ drive, create directories (folders) named H1H2SH and SAS at the root directory level (i.e., C:\H1H2SH and C:\SAS). The SAS programs use complete path names for these directories, so they do not need to be specified in the DOS path.
3) Copy the supplied files to the C:\ drive being certain that they are in the same directories on the C:\ drive as on the supplied disks. In Windows, the folders and all of their files can be copied directly to the C:\ drive. The folders and their contents should be

   C:\H1H2SH
      CNTRL.EXE
      EGA.GFN
      GP2.EXE
      GP3.EXE
      HELV12.GFN
      HELV8.GFN
      KCNTRL.EXE
      MO2H1DF.EXE
      MOH1DF.EXE
      MOH2DF0.EXE
      MOH2DF1.EXE
      MOH2DF2.EXE
      MOH2DFK.EXE
      MOH2OF.EXE
      MOSWDF.EXE
      RERNTOL.DAT
      RETRHYD.EXE
      SAS.EXE
      SIDEHYD.EXE
   C:\SAS
      [Input files for HEC-1, HEC-2, and SIDEHYD]

There should be a minimum of approximately 5 to 6 MB of free hard disk space (after HEC-1 and HEC-2 are installed). The exact amount of required disk space depends on the size of the input and output files.

3.3 - INPUT FILES

3.3.1 - General Requirements

Before execution of the Side-Diversion Analysis System, input files must be developed for HEC-1, HEC-2, and SIDEHYD. SAS uses these files as base data files from which to automatically construct its input files. Because the user is presumed to have experience preparing input files for HEC-1 and HEC-2, the description of these data files (Sections 3.3.2.1 and 3.3.2.2) will be limited to certain records and fields that pertain to linking them into the SAS model. The HEC-1 User's Manual (U. S. Army Corps of Engineers, 1990) and the HEC-2 User's Manual (U.

S. Army Corps of Engineers, 1994) or the on-line manuals at the web site given in Section 3.2 should be used for information on these input files. The SIDEHYD input file is described in Section 3.3.2.3.

Prior to executing SAS, the base data files for HEC-1, HEC-2, and SIDEHYD should be processed separately by their respective programs to be sure that they are free of input errors. SIDEHYD can be run from the DOS prompt by entering

C:\H1H2SH\SIDEHYD.EXE Input=path\filename

The output will go to active directory. It is necessary that

1) the HEC-1 base data file accurately model the hydrology in the subject watershed,
2) the HEC-2 base data file accurately model the hydraulics in the channels,
3) the SIDEHYD base data file accurately specifies dimensions and physical characteristics of the proposed diversion structures and detention basin,
4) there be consistency among these data files as to station numbering, elevations, and channel geometry, and
5) the station numbers for HEC-1 and HEC-2 increase in the upstream direction.

It is not necessary that there be the same number of stations in HEC-1 and HEC-2; either program can have the larger number of stations. However, it is essential for stations that are included in the input files for both programs to have exactly the same station numbers so that SAS can automatically find corresponding stations in the two programs. The Side-Diversion Analysis System makes its own copies of the base data files and modifies them; the original base files remain in tact during processing. Any interpolated flows in the HEC-1 base data file are not used by SAS.

3.3.2 - Input Files for One Diversion Structure

For diversion structures that are hydraulically independent (Section 2.1.6), multiple structures along a stream can be modeled and designed one at a time, provided that the process is started at the most upstream structure. The hydrographs for downstream structures must account for diversions at upstream structures.

For one diversion structure, SAS requires that the user specify one HEC-1 base data file, one HEC-2 base data file, and one SIDEHYD base data file. The user must also supply an UPWEIR station number (at the upstream end of the structure), an ATWEIR station number (in the middle of the structure), a DNWEIR station number (at the downstream end of the structure), and a Hydrograph Threshold discharge (the channel flow rate below which no calculations are made by SAS). UPWEIR, ATWEIR, and DNWEIR (Fig. 3.1) designations are used for both weirs and diversion culverts. UPWEIR is used only in HEC-1 and only to determine the hydrograph at the upstream end of the diversion structure. Thus, while it is conceptually at the upstream end of the structure, but it may actually be anywhere upstream that gives an accurate representation of the hydrograph at the upstream end of the structure.

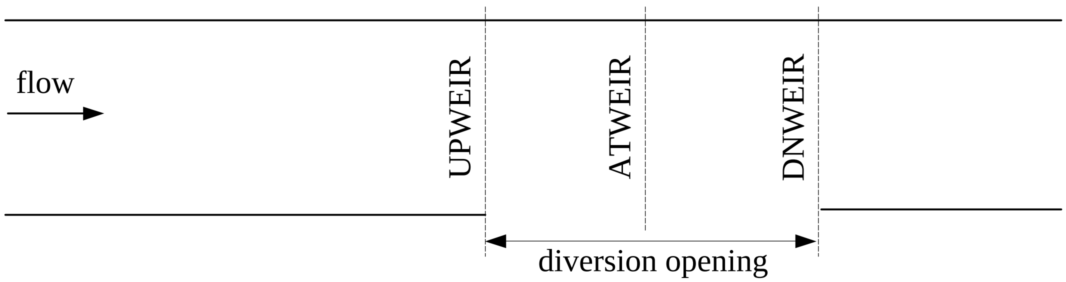


Fig. 3.1 - Schematic Plan View of Channel Showing UPWEIR, ATWEIR, and DNWEIR stations

Typical results for calculations for one weir are presented in Section 3.6.1 and for one set of diversion culverts in Section 3.6.3. The input files for these examples are given in Appendix 6.2. In that section and in the following examples, certain file naming conventions are used but are not required:

filename.H1D	an HEC-1 base data file
filename.H2D	an HEC-2 base data file
filename.SHD	a SIDEHYD base data file

3.3.2.1 - HEC-1 Input File

In addition to the normal requirements for a HEC-1 input file, the HEC-1 base data file for SAS must satisfy the following conditions:

- Stations that are included in the input files for both HEC-1 and HEC-2 must have exactly the same station numbers. Furthermore, these station identifications in HEC-1 must be station numbers, not alphanumeric designations, and must be integers. Alphanumeric station designations can still be used in HEC-1 for stations that are not also in HEC-2.
- The station numbers that are in both HEC-1 and HEC-2 must increase in the upstream direction.
- The HEC-1 base data file must include the stations for which QT records appear in the HEC-2 base data file.
- The UPWEIR station number must be a valid KK group identifier in the HEC-1 base data file. UPWEIR is the station at which the Hydrograph Threshold discharge is used to determine the time interval of interest for the analysis.

- The ATWEIR station number must be in field 1 (ISTAD) of the DT record.
- The DNWEIR station number must appear as a KK group identifier and must also be a cross section in the HEC-2 base data file.
- Each KK record for which hydrographs are the be read needs to be followed by a KO record with 1 or 2 in field 1 and with all of the other fields blank on the KO record.
- The HEC-1 base data file should include the first estimate of the diversion on DT, DI, and DQ records that immediately follow the KK record for the sub-basin upstream of the DNWEIR station. In the example below, the values on the DI and DQ records give an initial diversion of all flow above 12,000 cfs. The diversion specified in the base data file is used as the initial estimate of side-channel discharge.

The excerpt below is taken from the HEC-1 input file A1.H1D in Appendix 6.2.1 and illustrates the specifications for UPWEIR station 85292, ATWEIR station 85167, and DNWEIR station 85042 for a weir that is 250 ft long. These station numbers are underlined. The numerical values of the station numbers are used only for identification, not for any computations.

```
KK 85292FROM E100#6 (STA 913+78 TO STA 850+43
RS     1              -1
RC  0.12   0.035    0.12    6335 0.00095
RX     0       1       2      77     147     222     223     224
RY    25      25      25       0       0      25      25      25
KO     2
KK 85042DIVERT FLOW TO POND 25
DT 85167
DI     0    5000   12000   18000   25000
DQ     0       0       0    6000   13000
KO     2
KK 77969FROM E100#7 (STA 850+43 TO STA 779+68)
RS     1              -1
RC  0.12   0.035    0.12    7075  0.0008
RX     0       1       2      62     107     167     168     169
RY    24      24      24       0       0      24      24      24
KO     2
```

The HEC-1 input file for one set of diversion culverts (A1CULV.H1D, Appendix 6.2.2) is identical except for the DQ record, which was changed as shown below to account for the smaller diversion capacity of the diversion culverts:

```
KK 85042DIVERT FLOW TO POND 25
DT 85066
DI     0    5000   12000   20000   25000
DQ     0       0       0       0    3000
```

Proper functioning of the system requires correspondence of some stations specified in the hydrologic model (HEC-1 KK records, field 1) with cross sections specified in the hydraulic model (HEC-2 X1 records, field 1). Since HEC-2 requires integer cross section identifiers and HEC-1 does not, integer identifiers must be used in HEC-1 input at those stations that correspond in the HEC-2 file.

3.3.2.2 - HEC-2 Input File

In addition to the normal requirements for a HEC-2 input file, the HEC-2 base data file for SAS must satisfy the following conditions:

- Stations that are included in the input files for both HEC-1 and HEC-2 must have exactly the same station numbers. Furthermore, these station numbers must be integers.
- The station numbers must increase in the upstream direction.
- There must be a cross section at the DNWEIR station.

A sample input file called A1.H2D is in Appendix 6.2.5. The X1 record for the DNWEIR station (85042) and a few following records are shown below.

```
X1 85042      18   20300   20469    1300     800    1109
CI    -1   66.78   0.035     2.5     2.5     -45     -45
GR   100   18000      95   19050    90.7   20000    90.8   20100    90.9   20200
GR  89.5   20300    77.6   20327    75.1   20330    74.4   20337    74.8   20345
GR  77.6   20347      81   20430    94.7   20469    93.5   20500    93.3   20600
GR  93.7   20700      94   22600      95   22610
```

3.3.2.3 - SIDEHYD Input File

Compared to the previous version of the program (Davis and Holley, 1988), the input file for this version can include new features such as drainage culverts and diversion culverts. Nevertheless, the input file structure for SIDEHYD remains consistent with the previous program so that input files for the previous version can still be used. On the other hand, to maintain this consistency, the input file requires some parameters that are not used.

Example input files are given in Appendices 6.2.6 - 6.2.10. The following list shows the structure of the input file, which uses free formatting. This list is followed by the definitions of the parameters, most of which are also illustrated in Fig. 3.2 - Fig. 3.9.

```
OUTFIL, PLTFIL
NTITL
TITLE
TITLE
      etc. for NTITL lines.
IMON
CWIDTH, SS, SZ, ZD, MANN
TYPE, WRP, WRLEN, WRW, WRES (for weirs) or
```

```
TYPE, CLP, ANBBL, CLH, CLW, CLWT, CLLEN, CLMANN, CLAK, CLSLOPE (for diversion
   culverts)
NSTEP, NDSTEP, TCOMP, TPLT
NPD
YPD, APD
YPD, APD
      etc. for NPD lines.
ND
TSTR, WSELD, QDSTR
TSTR, WSELD, QDSTR
TSTR, WSELD, QDSTR
TSTR, WSELD, QDSTR
      etc. for ND lines.
```

NDRAINC GATE, STA, CDI, CHF, CWF, CLF, CIF, COF GATE, STA, CDI, CHF, CWF, CLF, CIF, COF etc. for NDRAINC lines.	These lines may be omitted.

where:

ANBBL	Number of diversion culvert boxes (Fig. 3.5).
APD	basin plan area (ac) at each YPD (Fig. 3.7).
CDI	pipe drainage culvert diameter (in.) (Fig. 3.8, Fig. 3.9). Use 0 for box culverts.
CHF	box drainage culvert height (ft) (Fig. 3.8, Fig. 3.9). Use 0 for pipe culverts.
CIF	drainage culvert invert elevation (ft) at inlet (Fig. 3.8).
CKE	drainage culvert entrance loss coefficient.
CKX	drainage culvert exit loss coefficient.
CLAK	entrance loss coefficient for diversion box culverts.
CLF	drainage culvert length (ft) (Fig. 3.8).
CLH	height of diversion box culverts (ft) (Fig. 3.5).
CLLEN	length of boxes of diversion culverts (ft) (Fig. 3.5).
CLMANN	Manning's coefficient for diversion culverts.
CLP	height (ft) of invert of outlet of diversion box culvert (relative to channel invert at downstream side of diversion culverts) (Fig. 3.5).
CLSLOPE	invert slope of diversion culverts (ft/ft), positive indicates a slope downward toward detention basin, negative is opposite (Fig. 3.5).
CLW	inside width of diversion box culverts (ft) (Fig. 3.5).
CLWT	width of walls between boxes of diversion culverts (ft) (Fig. 3.5).
COF	drainage culvert invert elevation (ft) at outlet (Fig. 3.8).
CRP	drainage culvert invert height above channel invert, not elevation (ft) (Fig. 3.8).
CWF	box drainage culvert width (ft). Use 0 for pipe culverts (Fig. 3.9).
CWIDTH	base width of trapezoidal channel cross section (ft) (Fig. 3.2, Fig. 3.5).
GATE	FLAP or FLEX, indicating the type of culvert check valve.
IMON	1 to show some results of computations on screen for monitoring progress, or

0 to suppress output to screen (no longer used but required in the input for consistency with earlier versions).

MANN Manning's n value for the channel.

ND number of sets of TSTR, WSELD, and QDSTR values for downstream hydrograph (Fig. 3.6).

NDSTEP number of dx steps for gradually varied flow computations in channel along weir end slopes for no flow and reverse flow over weir. Also used for weir flow computations for reverse flow (Fig. 3.4).

NDRAINC number of drainage culverts.

NPD number of sets of YPD and APD values.

NSTEP number of dx steps for gradually varied flow in channel along weir crest for no flow and for reverse flow over weir. Also used for weir flow computations for reverse flow (Fig. 3.4).

NTITL number of title lines. May be any value including zero.

OUTFIL output filename. No more than 40 characters enclosed in single quotes ('). No longer used.

PLTFIL plot filename. No more than 40 characters enclosed in single quotes ('). No longer used.

QDSTR channel discharges at downstream end of weir in input hydrograph (cfs) (Fig. 3.6).

SS side slope of channel trapezoidal cross section (Fig. 3.2, Fig. 3.5).

STA distance from a drainage culvert to the downstream end of the weir (ft) with positive being downstream and negative, upstream (Fig. 3.9).

SZ channel invert (bed) slope (ft/ft) (Fig. 3.3).

TCOMP computational time step (hr).

TITLE title. Each line must be enclosed in single quotes('). May be no more than 78 characters on each line.

TPLT time increment for PLT file (hr). This parameter has no effect on hydraulic calculations (no longer used but required in the input for consistency with earlier versions).

TSTR time for input hydrograph values (hr).

TYPE WEIR or CULV, indicating the type of diversion. If not specified, WEIR is assumed.

WRES end slope of weir for access road from top of berm to weir crest (Fig. 3.3).

WRLEN length of weir crest parallel to channel invert, excluding end slopes (ft) (Fig. 3.3).

WRP weir height above channel invert, not elevation of weir crest (ft) (Fig. 3.2, Fig. 3.3).

WRW width of weir crest in direction of flow over weir (ft) (Fig. 3.2).

WSELD input hydrograph water surface elevation at downstream end of weir (ft) (Fig. 3.6).

YPD elevation in basin (ft). Read in as elevation, then converted to be relative to ZD (Fig. 3.7).

ZD elevation of channel invert at downstream end of weir (ft) (Fig. 3.3).

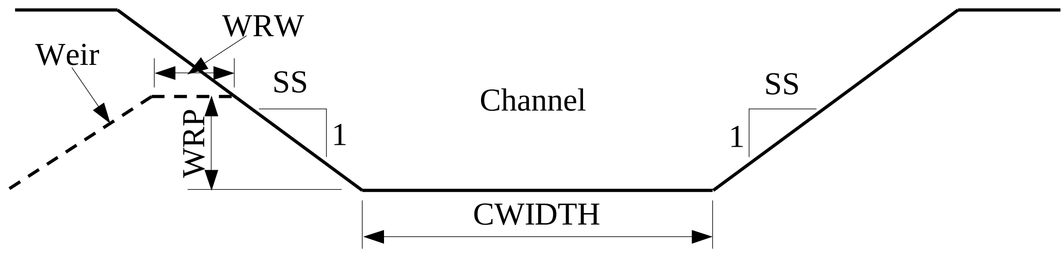


Fig. 3.2 - Definitions for the Channel and Weir, Looking along the Channel Axis

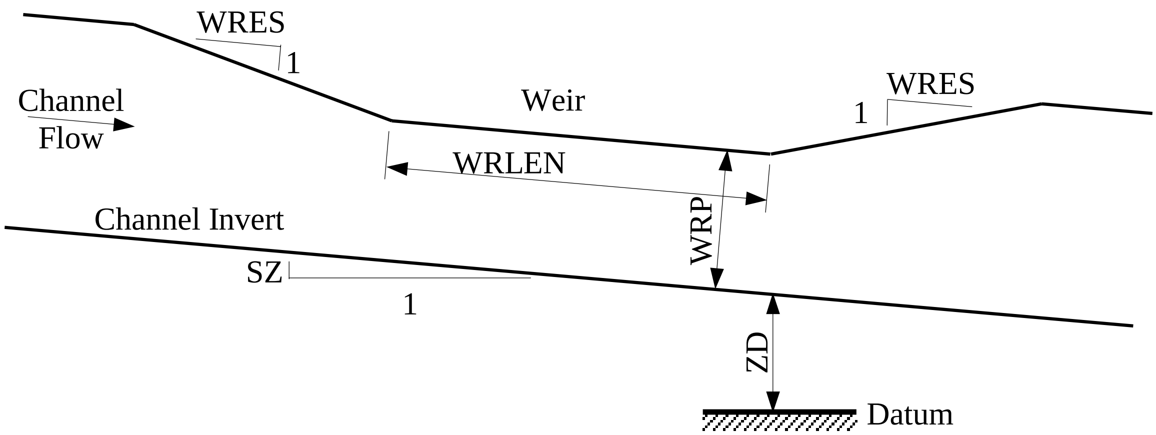


Fig. 3.3 - Definitions for the Channel and Weir, Looking Normal to the Channel Axis

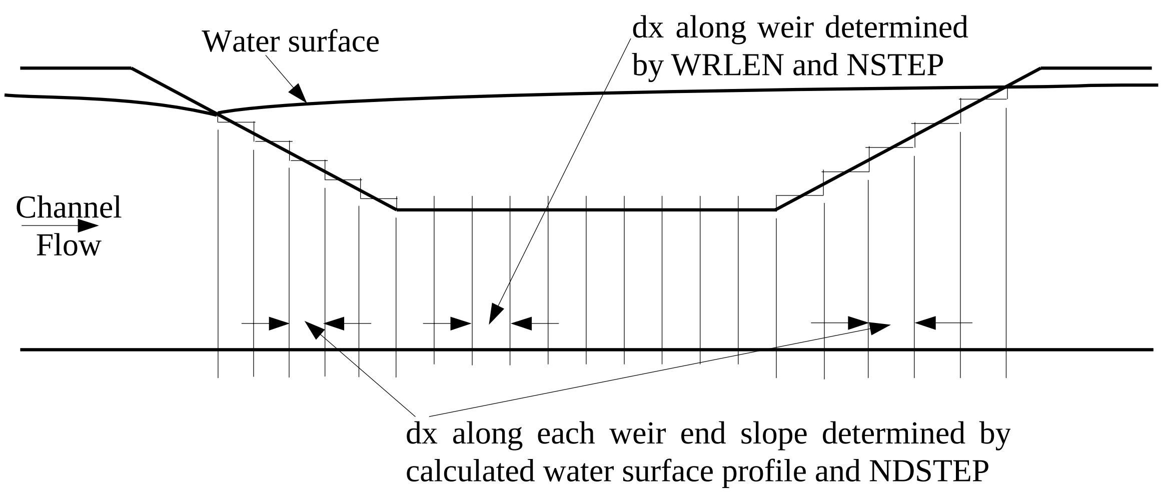


Fig. 3.4 - Definitions for Computational Parameters for the Weir, Looking
Normal to the Channel Axis

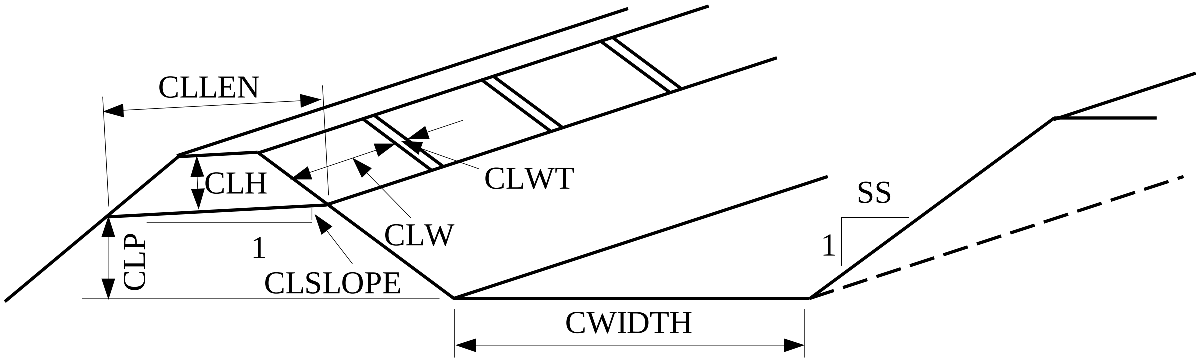


Fig. 3.5 - Definitions for Diversion Culverts, Isometric View

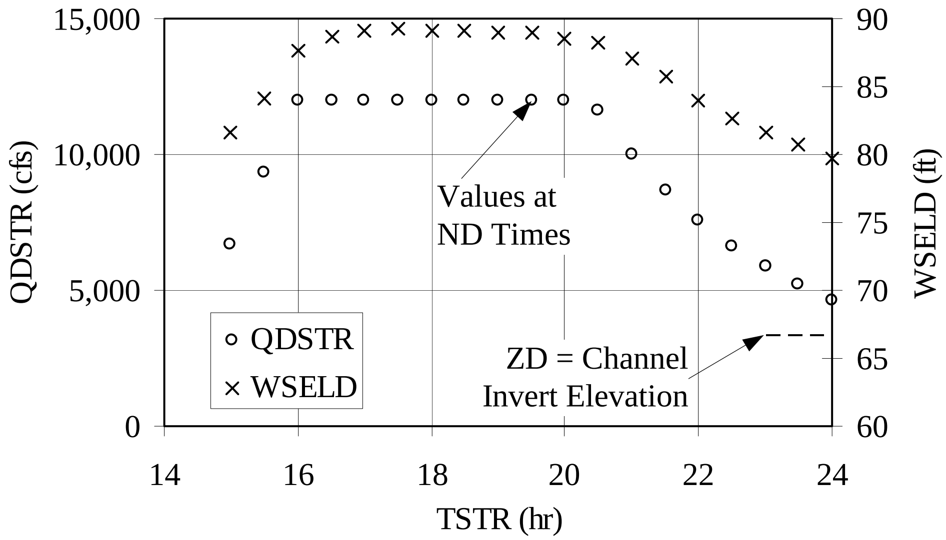


Fig. 3.6 - Parameters for the Input Discharge and Stage Hydrographs at the Downstream End of the Weir or Diversion culverts

Basin drainage culvert modeling is implemented by adding input records at the end of the file. The first of these records must indicate the number of culverts. Subsequent records, one for each culvert, must specify the culvert's location (distance in feet) from the downstream end of the weir (with positive distances being downstream and negative, upstream), the diameter in inches if the outlet is a pipe, the height in feet and the width in feet if the outlet is a box, the length in feet, the elevation of the invert in feet at the basin end, and the elevation of the invert in feet at the channel end. For a circular pipe culvert, the height and width must be specified as zero. Similarly, for a box culvert the diameter must be specified as zero.

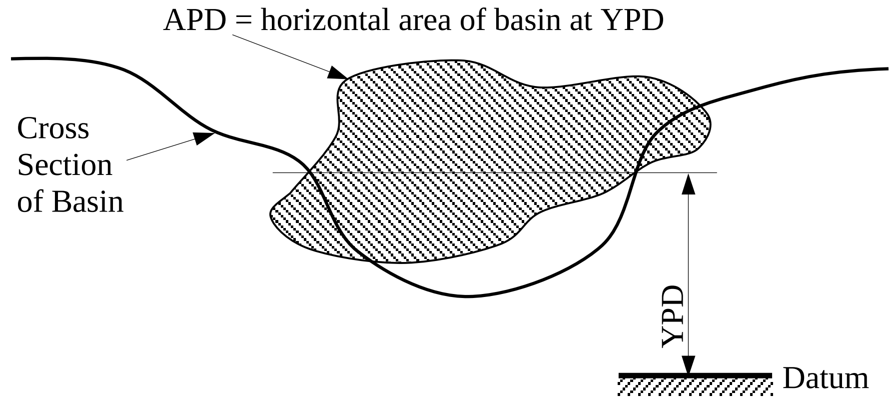


Fig. 3.7 - Definitions for a Detention Basin

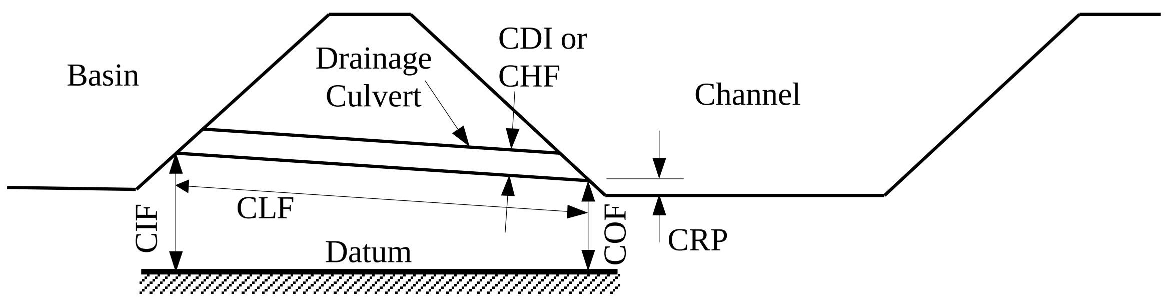


Fig. 3.8 - Definitions for the Vertical Position of Drainage Culverts, Looking along Channel Axis

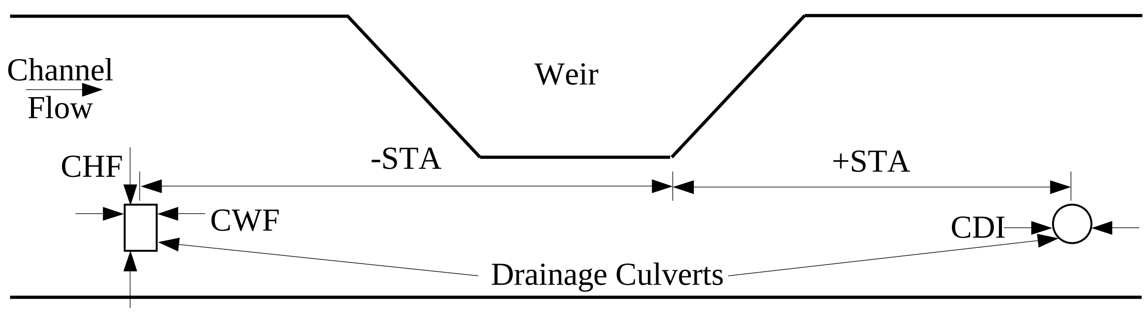


Fig. 3.9 - Definitions for the Longitudinal Position and Sizes of Drainage Culverts, Looking Normal to the Channel Axis

The following selection is taken from SIDEHYD input data file A2.SHD (Appendix 6.2.8) and illustrates the input required.

```
2
FLAP   100.   12.   0.   0.   100.   68.   67.
FLEX  -900.   60.   0.   0.   100.   68.   67.
```

The example is for two drainage culverts. The first culvert is located 100 feet downstream of the downstream end of the weir. It has a flap gate. It is a 12-in. diameter pipe, 100 ft long, with invert elevation 68 ft at the basin end and 67 ft at the channel end. The second culvert is located 900 feet upstream of the downstream end of the weir. Equipped with a Tideflex valve, it is a 60-in. pipe, with length and invert elevations identical to the previous culvert. (The program allows a specification of NONE rather than either FLAP or FLEX, but this option should not be used since the program does not calculate flow into the basin through a culvert with no check valve.)

The inclusion of drainage culverts can slow the SAS calculations considerably. This effect occurs both because the calculations for drainage culverts is rather slow and because the Hydrograph Threshold needs to be decreased so that the program will run long enough to see the effects of the drainage culverts. Since the flow through drainage culverts is normally much slower than the reverse flow over a side weir or through diversion culverts, it is recommended that SAS be run without drainage culverts for designing the diversion weir or diversion culverts. After the design is complete, drainage culverts can be added to determine their effects on draining the water stored in the basin below the weir crest. The final diversion and channel hydrographs could also be used to obtain an improved estimate of values to be entered in the DI and DQ records for the base HEC-1 input file and possibly decrease the running time for SAS.

3.3.3 - Input Files for Two Diversion Structures

SAS is capable of modeling two diversion structures along the same stream. When two structures are close enough together to be hydraulically dependent (Section 2.1.6), they should be modeled at the same time. As for one structure, there must be one HEC-1 base data file and one HEC-2 base data file (Sections 3.3.2.1 and 3.3.2.2). In these files, the UPWEIR, ATWEIR, and DNWEIR station numbers must be specified for each structure. The rules that apply to the specification of UPWEIR, ATWEIR, and DNWEIR stations in the HEC-1 and HEC-2 base data files are the same for the two diversion problem as those described earlier for one diversion. For the two-diversion case, there must be two SIDEHYD base data files. Each of these files is prepared as for the one-diversion case.

Input files for an example with two weirs are given in Appendices 6.2.3, 6.2.5, 6.2.6, and 6.2.9. Typical results are presented in Section 3.6.2. Input files for an example with two sets of diversion culverts are given in Appendices 6.2.4, 6.2.5, 6.2.7, and 6.2.10. Typical results are presented in Section 3.6.4.

3.4 - EXECUTION

The Side-Diversion Analysis System may be executed by making the C:\SAS directory the active directory in DOS and typing

C:\SAS **GO**

This command invokes a batch file, named GO.BAT, that issues the commands necessary to reset and start the system. The first thing that the batch files does is to delete the output files from any previous runs of SAS since the files are automatically given the same names by each execution of SAS. Thus, if it is desired to save any previous output files, they must be moved or renamed before running SAS again. Also, after typing GO, the first thing that may be seen on the screen is some messages that files could not be found. This type of message immediately after starting SAS does not indicate a problem; it occurs because the batch file (GO.BAT) that deletes old files (and then executes SAS) is written to delete files for both one-diversion and two-diversion cases, but all of these files generally do not exist at the same time. Next, the batch file executes a Visual Basic User Interface (Fig. 3.10 for one diversion or Fig. 3.11 for two diversions). The interface is for input data filenames, station numbers, and a Hydrograph Threshold discharge (Section 2.2.2.2). Blank fields on the interface for filenames may be filled by typing or by clicking on filenames in the directory windows in the right part of the interface screen. The small arrow in the upper, right part of the white area can be used for changing drives. The light gray rectangle on the right side of the two boxes below the drive designation (i.e., the boxes showing the directories in the selected drive and then the files in the selected directory) is the scroll bar. When the DOS window is in full-screen mode (which can be toggled by ALT-Enter), clicking on one of the fields in the left part of the screen for a filename and then clicking on the filename in the right part of the screen enters the filename into the previously selected field. For one diversion (Fig. 3.10), only the top field for the SIDEHYD input filenames should have an entry and only the left fields for the station numbers should have entries. For two diversions (Fig. 3.11), the first SIDEHYD input file should be for the upstream (U/S) diversion and the second one for the downstream diversion (D/S). The left column of station numbers is for the upstream diversion and the right column for the downstream diversion. The Hydrograph Threshold discharge is used at the UPWEIR station of the upstream diversions structure.

To exit from the SAS User Interface without initiating an analysis, use the button labeled ‘EXIT’. To begin analysis, use the button labeled ‘CALC’. The SAS User Interface then initiates a process that executes HEC-1, HEC-2, and SIDEHYD in sequence, for multiple iterations until the process converges. The execution can be stopped with Ctrl-Break. Depending on the point in the execution at which a break is tried, it may be necessary to press Ctrl-Break multiple times before the operating system recognizes the command.

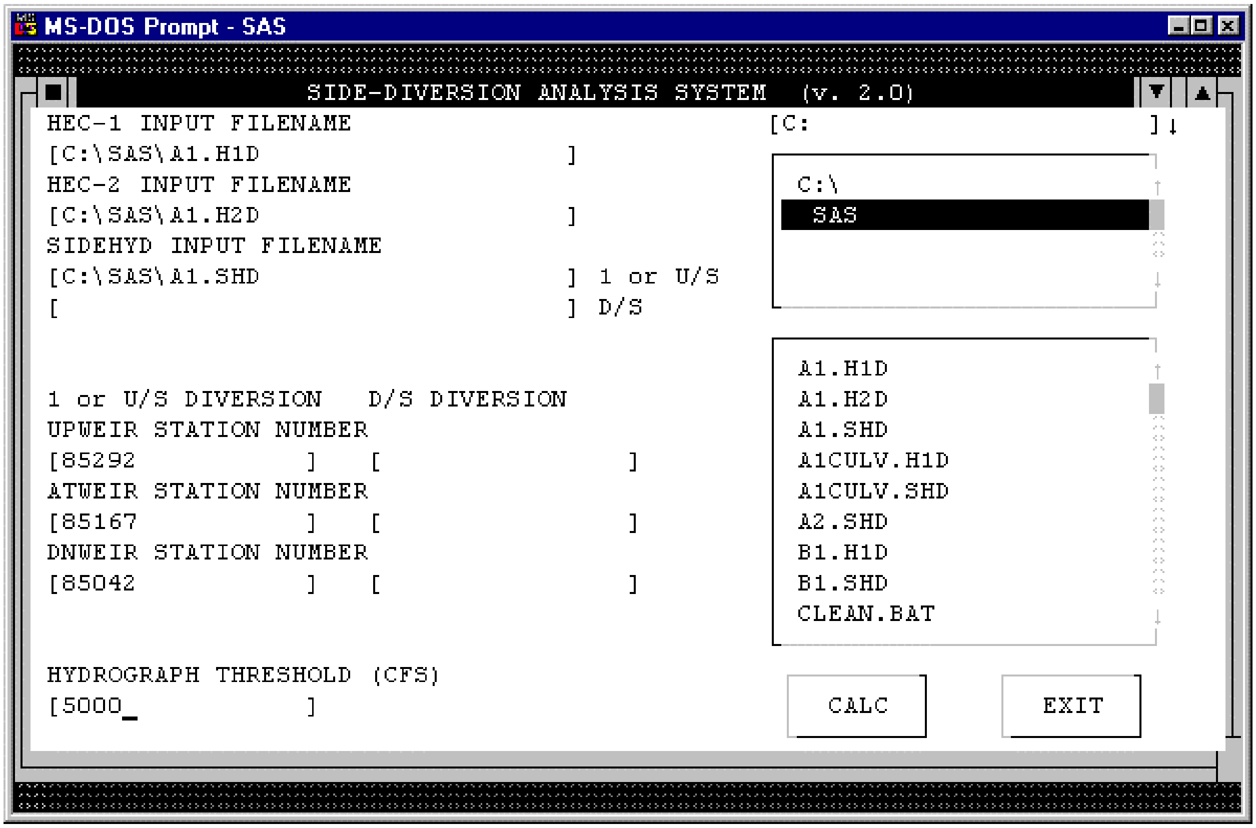


Fig. 3.10 - SAS User Interface example for one weir

Progress of the calculations can be monitored as the programs are executed at the DOS level by batch processors. In addition, a graphical display of the weir performance is given at the end of each iteration. This graph remains on the screen for 10 seconds. If a keypress is detected during that 10 seconds, the execution pauses and the graph remains on the screen until another keypress is detected. Pressing "P" or "p" to resume the calculation sends the screen graphic to a printer. The printed graphs are draft quality, not report quality. (See also the second paragraph below and Section 3.5.1.)

The sequential execution of HEC-1, HEC-2, and SIDEHYD continues until a solution is found that satisfies the convergence criterion. This criterion is based on MERN, which is the Maximum ERror (difference) Normalized between the assumed and calculated diversion hydrographs. The normalization is with respect to the maximum diversion discharge. A final graph displays the flow and stage at the upstream end of the diversion structure, in the basin, and at the downstream end. A keypress for the one-diversion case returns control to DOS. For two diversions, a keypress is used to move from the final graph for the upstream structure to the final graph for the downstream structure. Then another keypress returns to DOS. The user should then inspect the final HEC-1, HEC-2, and SIDEHYD output files (Section 3.5.3) for warnings or error messages.

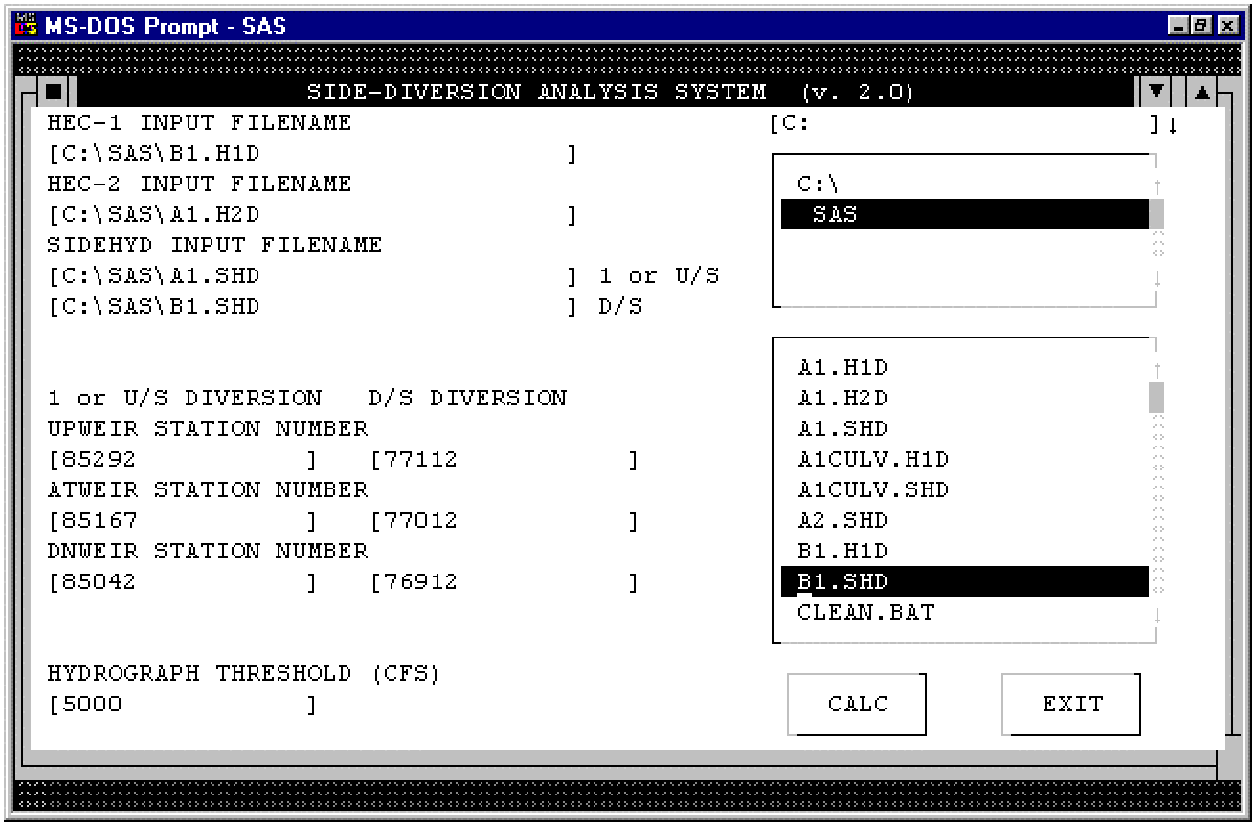


Fig. 3.11 - SAS User Interface example for two weirs

As mentioned above, execution will pause if a key is pressed while one of the graphs showing progress of the iterations is on the screen. For the one diversion case, pressing a key to pause the execution while the graph is showing and then pressing "S" or "s" will cause the execution to proceed as if the convergence criterion had been met. Use the same approach for the graph for the downstream diversion for the two-diversion case. This technique is useful if the graphs showing the progress of the iterations indicate that the calculations have converged to the user's satisfaction even though the numerical convergence criterion has not been met.

The final output files (Section 3.5.3) must be inspected for errors or warnings. The filenames and locations are written to the screen at the end of the execution of SAS, if the execution terminates normally.

3.5 - OUTPUT

The output files generated by HEC-1, HEC-2, and SIDEHYD are overwritten with each iteration; only the final output files are preserved. Overwriting the intermediate files is necessary because of the large size and number of output files and the potentially large number of iterations required for an analysis. In addition to the final output files, SAS produces graphic output to the monitor at every iteration and a final graphic output when the convergence criterion is met. It normally is not necessary to preserve the intermediate input and output files. Nevertheless, they can be preserved if the programs are being run from a DOS window in Windows. To preserve the files, cause the execution to pause by pressing a key while a graph is on the screen, minimize the DOS window, and then use the Explorer to copy the files. Do not delete or rename any of the input and output files while SAS is running. The filenames are shown in Table 4.1 and Table 4.2. See also Section 3.5.3.

3.5.1 - Screen Plots

A graph comparing the assumed and calculated diversion flows for each iteration allows the user at the end of every iteration to monitor progress toward solution. Graph titles indicate the names of the base data files used in the analysis, the iteration count, and the error statistics. RMSE, the root mean squared error, is an overall goodness of fit statistic that is computed by squaring the difference between the previous and the present calculated diversion discharges for each time step for the hydrograph, averaging the squares, and taking the square root. RMSE is shown on the screen plots for information only. The convergence criterion for SAS is based on MERN (Section 3.4). Both RMSE and MERN are calculated using all of the points in the SIDEHYD calculations. Only some of these points are shown in the graphs.

The graph at the end of each iteration remains on the screen for ten seconds unless a keypress is detected. A keypress keeps the graph on the monitor and the analysis pauses until another keypress is detected.

The graphs for the examples in Section 3.6 are captured screen plots. If the program is being run in a DOS window under Windows, a key can be pressed during the normal 10 seconds that a graph is on the screen at the end of one of the iterations. This action causes a pause in the program execution and keeps the graph on the screen. The final graph stays on the screen indefinitely (until a key is pressed). Alt-Enter will cause the full screen graph to go into a smaller window. Alt-Print Screen will copy the window onto the clipboard, so that it can be pasted into other applications. The figure can then be resized or cropped as desired. To restart the program, make the DOS window the active window, and then use Alt-Enter to cause the window to return to full-screen size. Pressing a key will cause the program to resume execution.

3.5.2 - Hard Copy Plots

To obtain printed plots directly from the program, a keystroke is needed to pause execution while the graph at the end of one of the iterations is on the screen. The final graph remains on the screen without pressing a key. Pressing "P" or "p" while execution is paused and a graph is on the screen produces a printed copy of the plot that was on the screen and resumes execution of the programs (or terminates the execution for the final graph). Any other key except "S" or "s" (Section 3.4) will resume execution without generating a printed plot. The hard copy plot is in black and white and is draft quality, not report quality. The output files SIDEHYD.PLT for one diversion or SIDEHYD.PL1 and SIDEHYD.PL2 for two diversions contain the data used to produce the graph of the final results at the end of the computations. These are ASCII (text) files with constant-width columns that may be used in spreadsheets and graphing programs. The columns in the files are time in hours, water surface elevation (ft) at the downstream end of the diversion structure, discharge (cfs) at the downstream end of the structure, water surface elevation (ft) at the upstream end of the structure, discharge (cfs) at the upstream end of the structure, the combined diversion discharge (cfs) through the diversion structure and drainage culverts (if any) with negative being into the basin and positive into the channel, water surface elevation (ft) in the basin, and elevation (ft) of the weir crest or of the invert of diversion culverts. See also Section 3.5.1 for information about capturing screen plots.

3.5.3 - Program Output Files

The output files are in the SAS directory. The results of the calculations are found primarily in the output file of program SIDEHYD (SIDEHYD.OUT for one weir; SIDEHYD.OU1 and SIDEHYD.OU2 for the upstream and downstream weirs, respectively, for two weirs). See also Section 3.5.2.

HEC-1 output from the final iteration is in the file HEC1.OUT. HEC-2 output from the final iteration of multiple runs is in files D01 - Dn, where n is the number of HEC-2 runs that were required to cover the time interval of interest. The number n is in Fortran I2.2 format so that the name is D04 when n = 4 and D11 when n = 11. These are ASCII text files and may be inspected using a text editor or loaded into a spreadsheet for graphing.

It is imperative that the output files for HEC-1, HEC-2, and SIDEHYD be inspected for warnings and errors.

3.6 - EXAMPLES

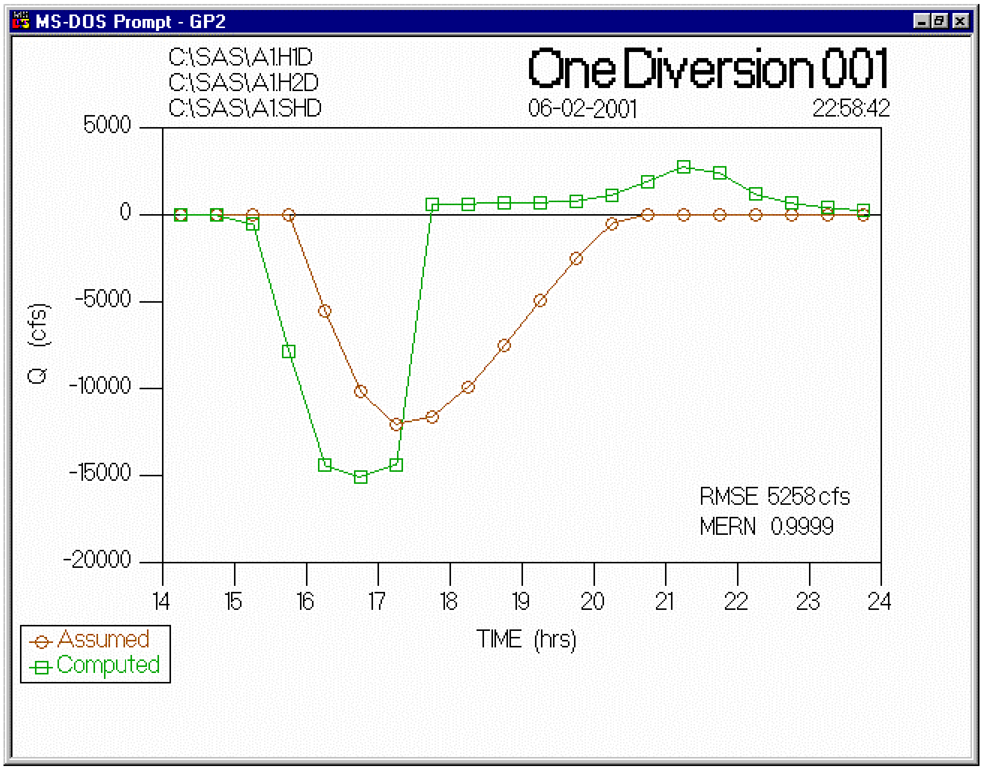
3.6.1 - Example with One Weir

Fig. 3.10 displays the User Interface for an example with one weir and includes the UPWEIR, ATWEIR, and DNWEIR stations. The input files are in Appendix 6.2.1, 6.2.5, and 6.2.6. This weir is 250 ft long and 17 ft high. The filenames that appear in the input fields may include the complete path or only the filename if the input files are in the local (SAS) directory. The blank input fields in Fig. 3.10 are used only for two weirs.

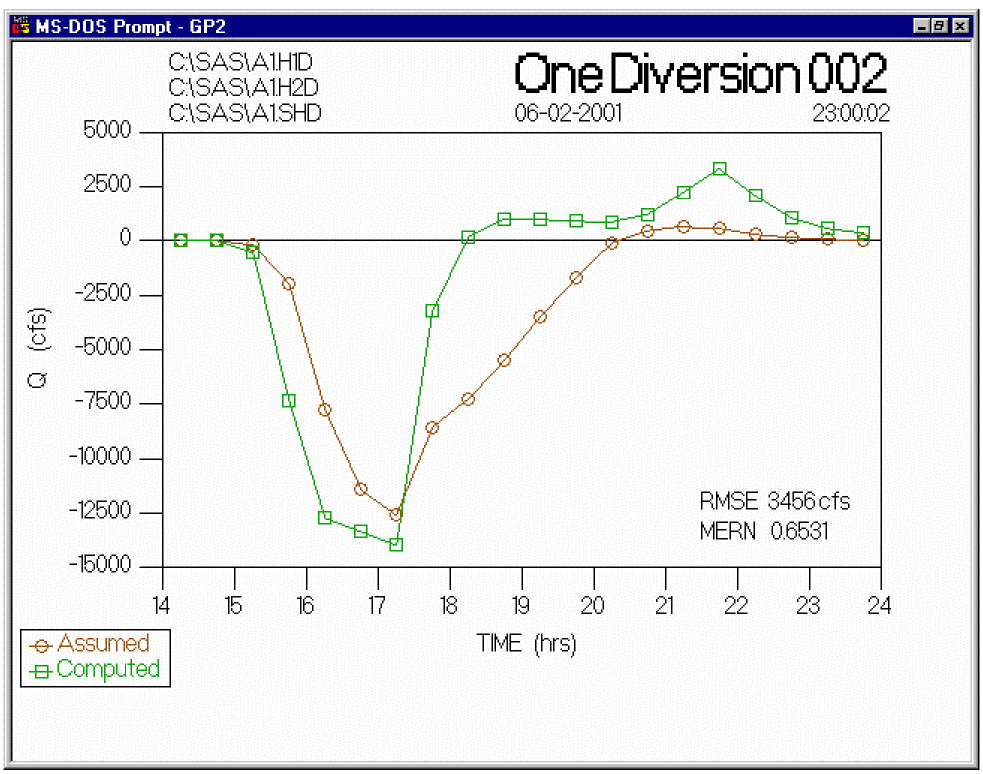
The various parts of Fig. 3.12 show the graphs that are generated during the iterations. The upper left part of the screen gives the input filenames for HEC-1, HEC-2, and SIDEHYD. "One Diversion" indicates that these calculations are for a situation with one diversion (as contrasted to two diversions in the next example). The number after "One Diversion" is the iteration number. The date and time when the calculations were done are shown below "One Diversion" and the iteration number. There are many more points in the SIDEHYD calculations than are shown in the figures (or than are given in the output files). The various curves have on-screen color coding. Each graph shows the diversion hydrograph assumed at the beginning of the iteration and the hydrograph calculated by SIDEHYD. Negative diversion discharges are into the basin while positive discharges are reverse flow from the basin into the stream. Reverse flow occurs for cases when the basin is filled above the weir crest and then the stage in the stream falls below the water level in the basin. This example converged in eleven iterations.

In Fig. 3.12a, the assumed hydrograph for the first iteration is the one obtained by truncating the hydrograph at the upstream end of the weir. Thus, the assumed hydrograph has no reverse flow. There are large differences between the assumed and computed hydrographs for this first iteration. The root-mean squared-error (RMSE) is 5258 cfs. The MERN (Maximum ERror Normalized) is 0.9999. In general, MERN gives the ratio of the maximum difference between assumed and calculated diversion hydrographs divided by the maximum diversion discharge. However, if the value is 1 or larger, the value 0.9999 is written on the graph.

The assumed hydrograph in Fig. 3.12b is the weighted average of the two hydrographs in Fig. 3.12a with a weight of 0.75 applied to the previously assumed hydrograph and 0.25 applied to the previously calculated hydrograph. In each iteration, the assumed diversion hydrograph is this type of weighted average of the assumed and computed hydrographs from the previous iteration. The various parts of Fig. 3.12 illustrate that convergence is achieved first for the earlier times on the hydrograph and then progressively for later times in subsequent iterations. Fig. 3.12f shows the assumed and computed hydrographs for the final iteration. The poorest convergence is normally for the reverse flow or when the flow is close to zero due to having approximately the same head water and tail water levels. The convergence tolerance is set at 0.075, so the calculations stop when MERN falls below 0.075 (7.5%). In this case, there are differences between the assumed and calculated diversion hydrographs of about 720 cfs (0.0573 times the maximum discharge of approximately 12,600 cfs) for short periods of time with an RMS error of 244 cfs. The time with the largest difference between the assumed and calculated diversion discharges may not be one of the points plotted in the figure.

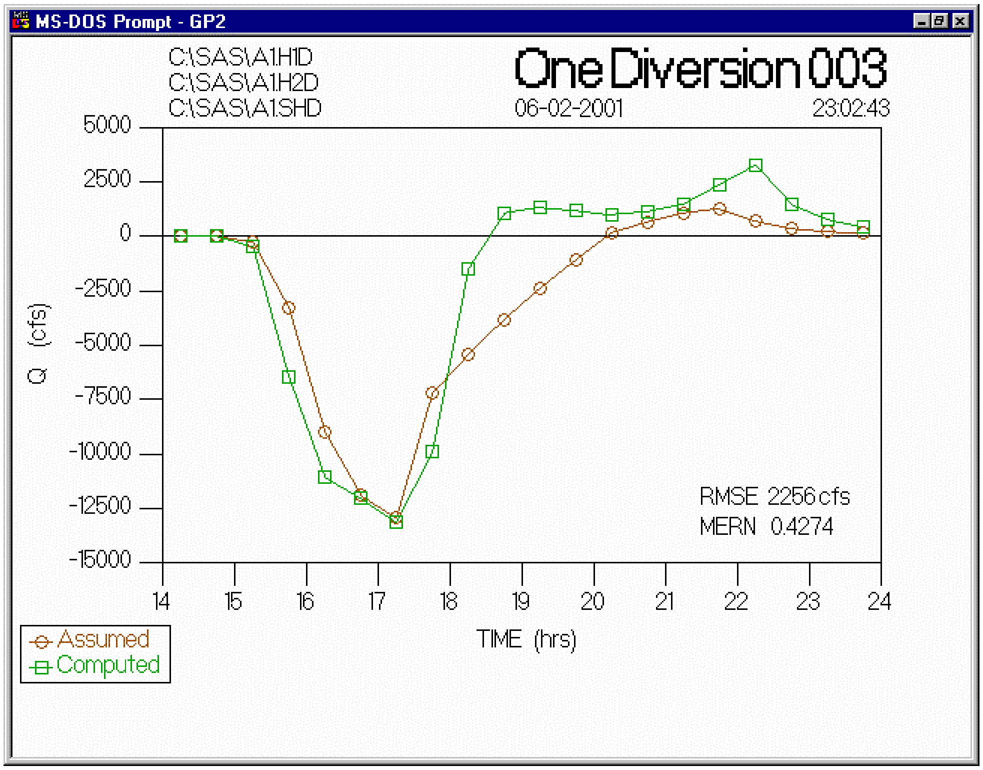


(a) End of first iteration

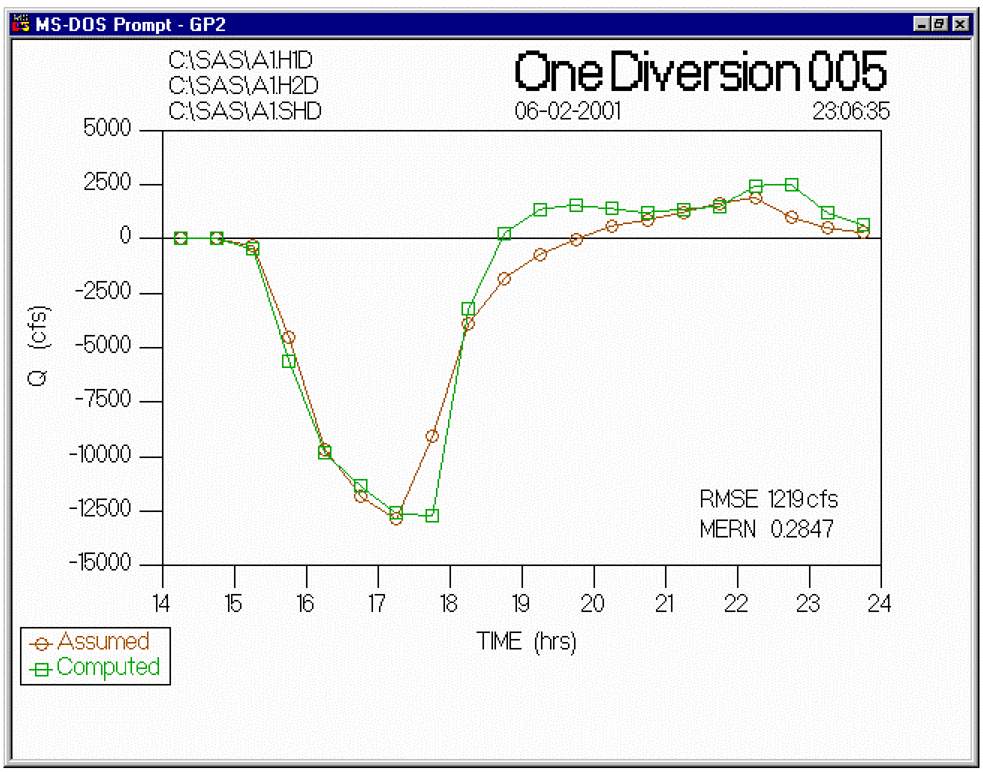


(b) End of second iteration

Fig. 3.12 - Plots during the iterations for one weir

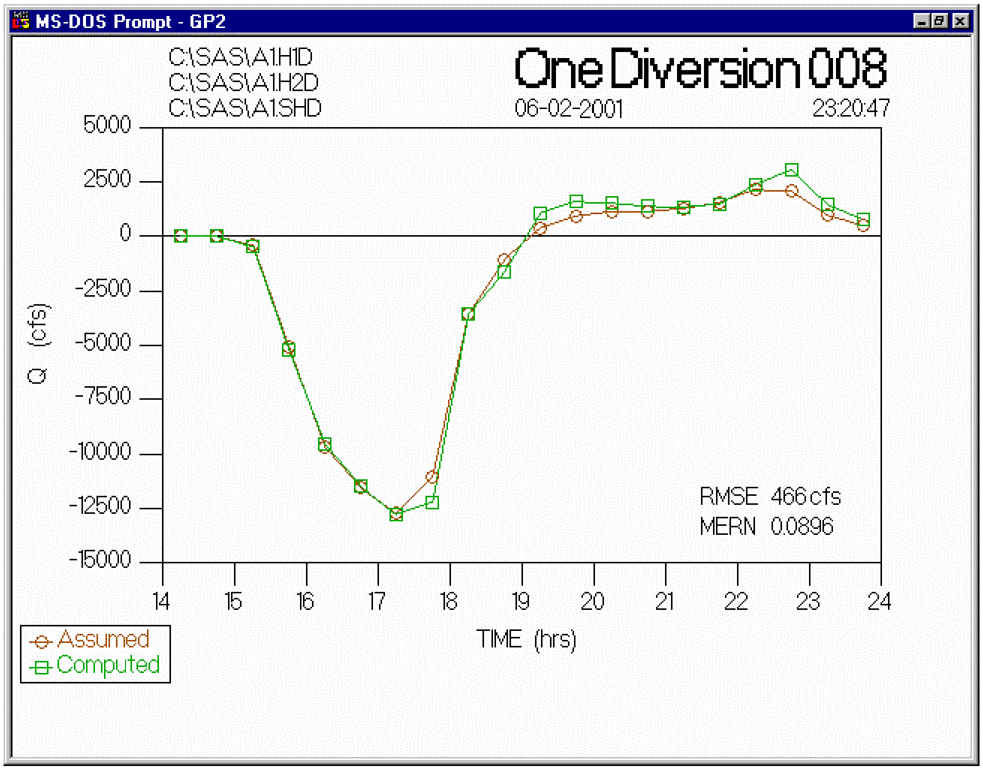


(c) End of third iteration

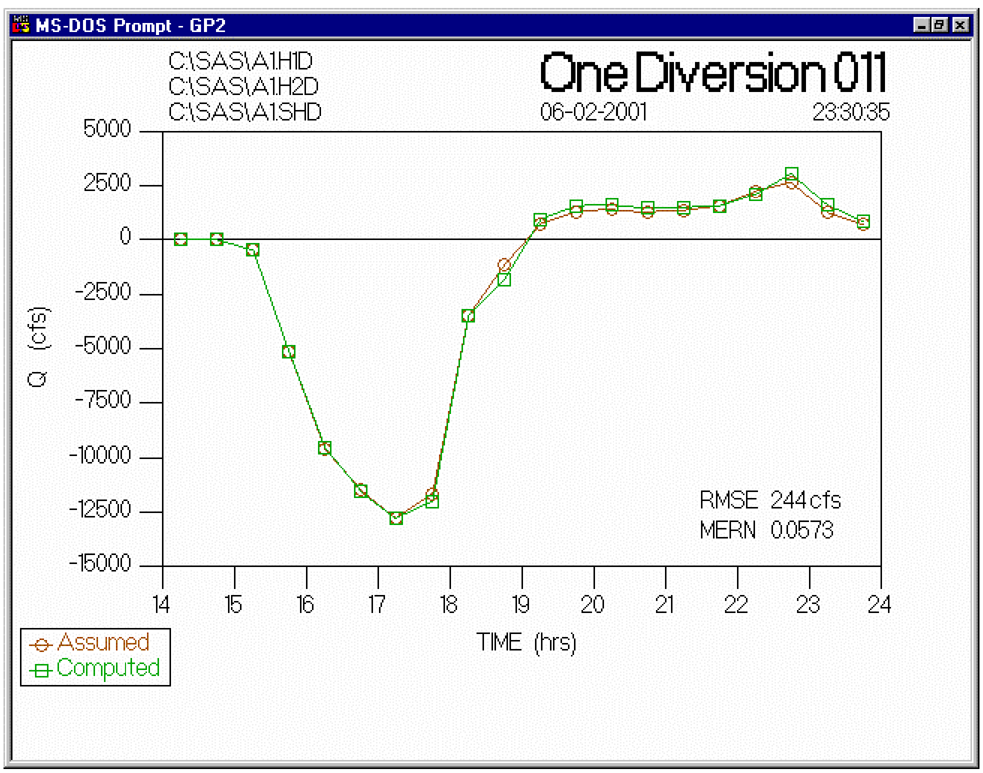


(d) End of fifth iteration

Fig. 3.12 - Plots during the iterations for one weir (continued)



(e) End of eighth iteration



(f) End of eleventh and final iteration

Fig. 3.12 - Plots during the iterations for one weir (continued)

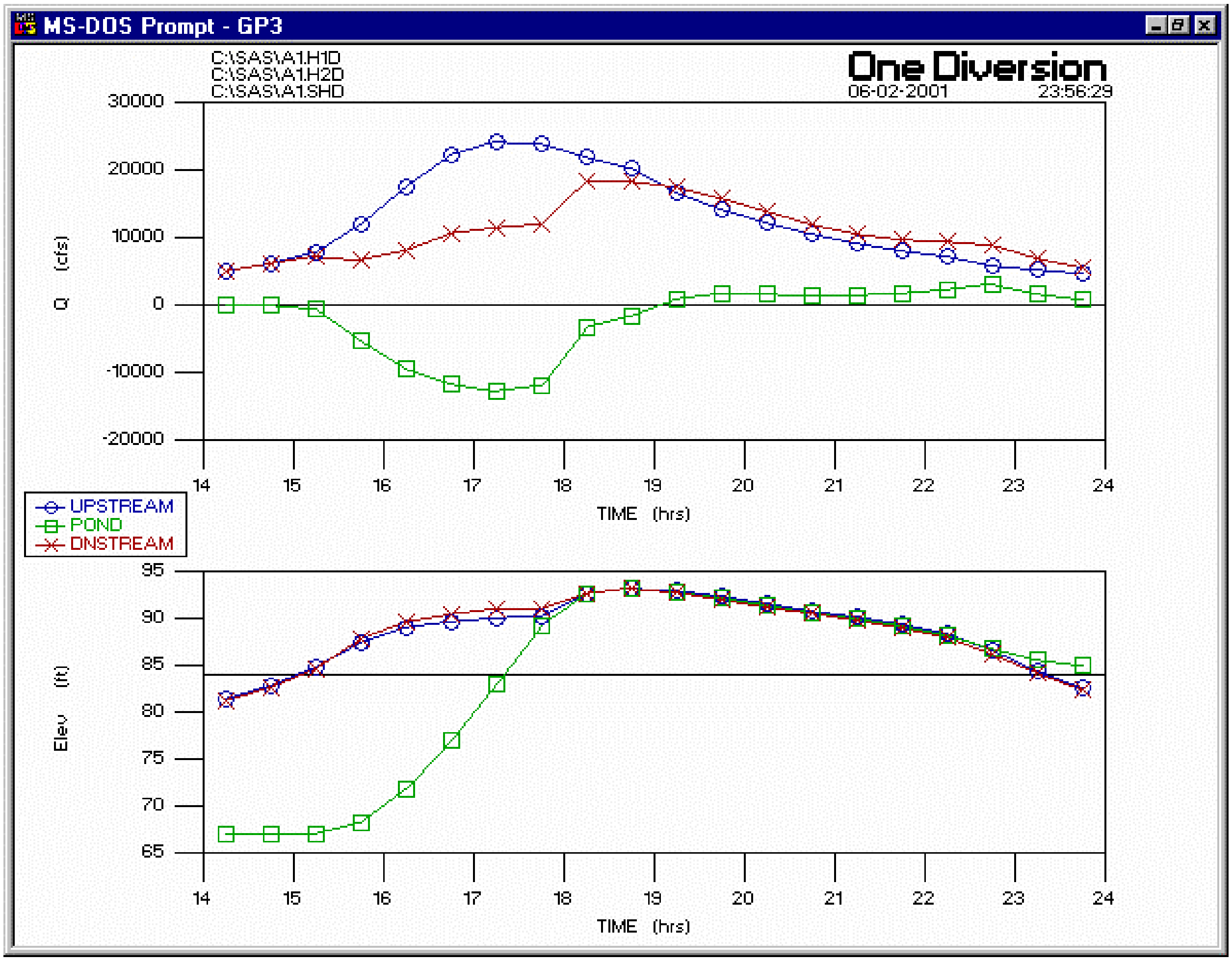


Fig. 3.13 - Final plot after nine iterations for one weir

A summary of the final results is shown in Fig. 3.13. The top part of the figure shows the discharge hydrographs while the bottom part shows the stage hydrographs. "Upstream" and "Downstream" refer to the channel at the upstream and downstream ends of the diversion structure. The difference between the upstream and downstream discharge hydrographs is the flow over the weir, which is shown as the pond hydrograph. The stage hydrographs illustrate that the stage is higher at the downstream end of the weir for subcritical channel flow when there is flow into the basin. When the stages in the stream and in the basin are equal, discharge into the pond is zero. After that time, the stages stay very close to each other as the reverse flow occurs; the stage in the pond is slightly higher than in the stream in order for the reverse flow to occur.

This example has no drainage culverts, so the water level in the basin gradually approaches the weir crest as the flow in the stream reaches the Hydrograph Threshold of 5000 cfs. As can be seen at the beginning and the end of the stage hydrographs, this Hydrograph

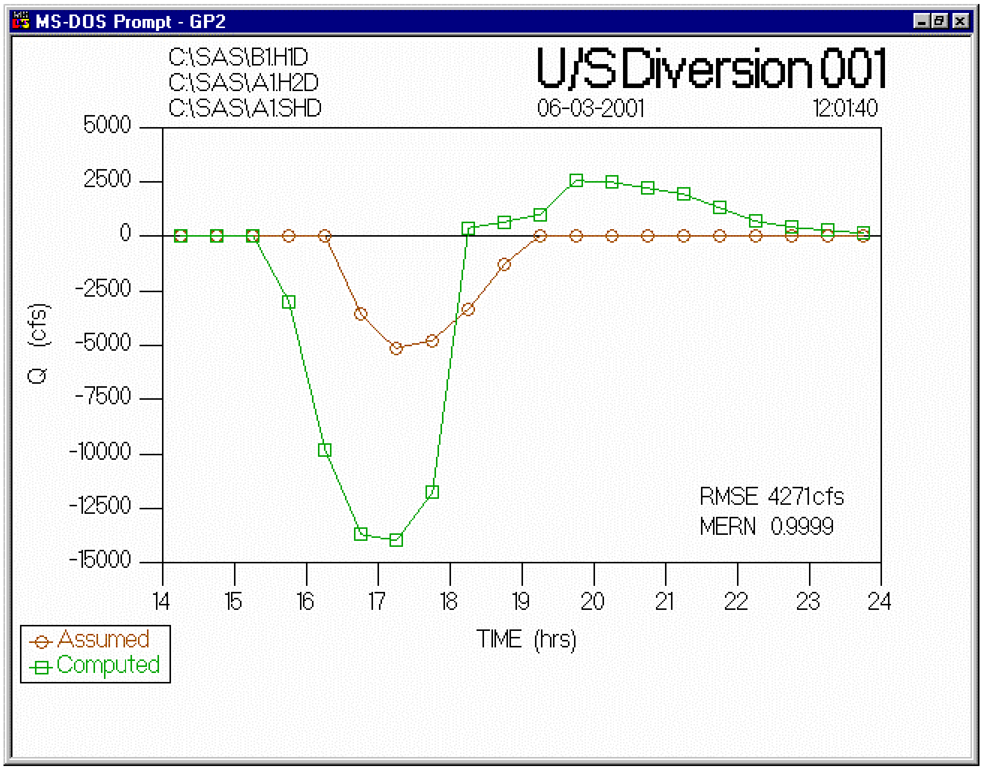
Threshold gives stages that are slightly below the weir crest. The final graph (Fig. 3.13) remains on the screen indefinitely when the calculations are finished.

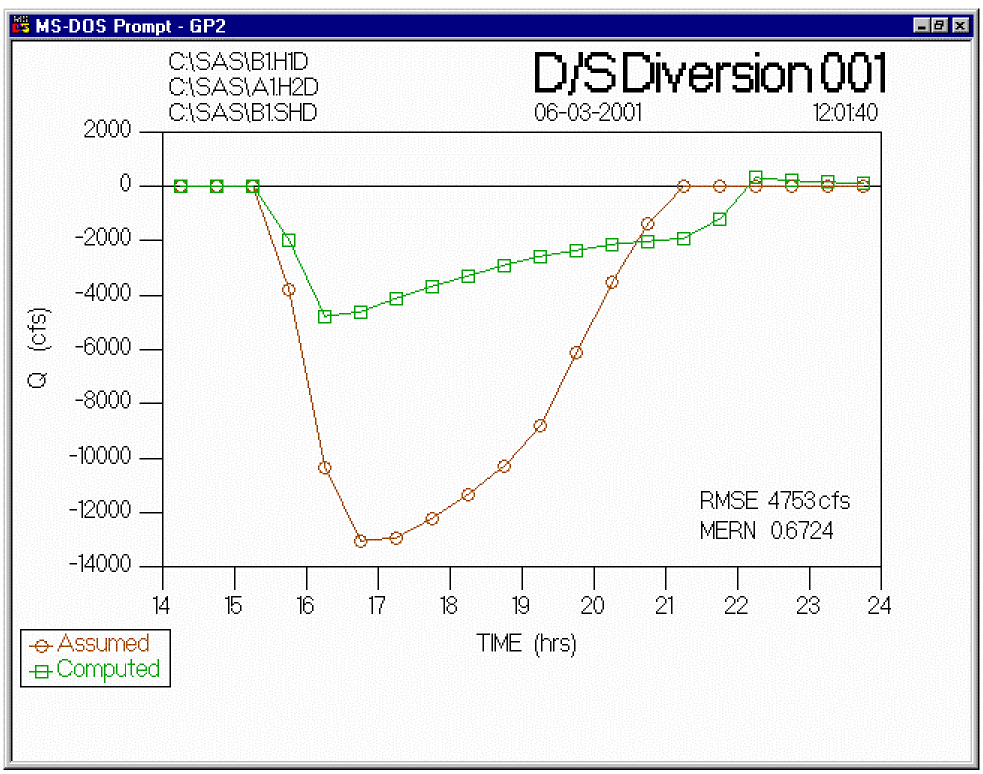
This run required about 6 1/2 minutes on a 120 MHz computer using a DOS window in a Windows 95 operating system and about 2 minutes on a 900 MHz laptop computer with Windows 2000. This was the time requirement with no interruptions (except for the 10-second pauses for each iteration graph shown on the screen); the program was run once to capture the screen plots and run another time without interruption to determine the execution time. The times given for all of the subsequent examples also include the pauses for displaying the graphs.

3.6.2 - Example with Two Weirs

Fig. 3.11 is the User Interface for an example with two weirs and includes the UPWEIR, ATWEIR, and DNWEIR stations for both weirs. The upstream weir is the same one as in the example with one weir in Section 3.6.1. The downstream weir is 200 ft long and 17 ft high and is about 1.5 miles downstream of the first one. The input files are in Appendices 6.2.3, 6.2.5, 6.2.6, and 6.2.9.

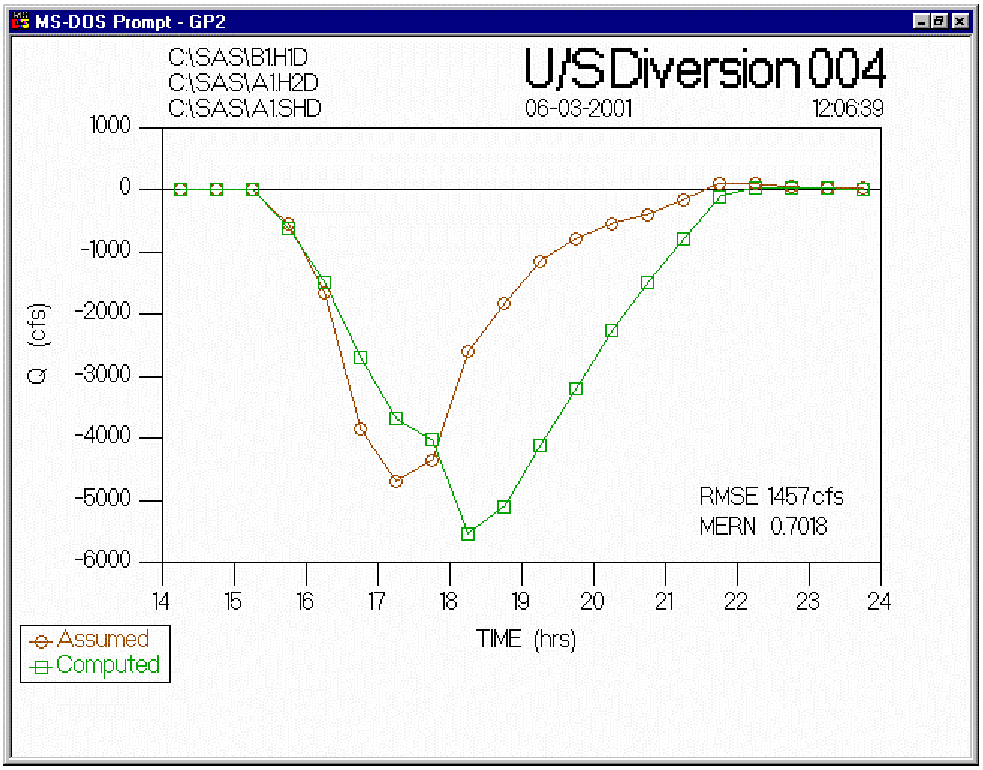
The assumed and calculated diversion hydrographs are shown in the various parts of Fig. 3.14, which are essentially the same as the graphs for one diversion in Section 3.6.1. On the graphs for two diversions, U/S means the upstream diversion structure and D/S means the downstream diversion structure. As Fig. 3.14a shows, there were large differences at both weirs between the initially assumed diversion and that calculated in the first iteration. By the 4th iteration (Fig. 3.14b), the magnitudes of the assumed and calculated diversions are beginning to be similar, but there are still significant differences in the timing of the assumed and computed diversion hydrographs at the upstream weir. During the 5th iteration (Fig. 3.14c), a spike develops in the computed hydrograph for the downstream weir. The effects of this spike propagate to the upstream weir, so that there is a definite irregularity in the hydrographs that can be seen at the end of the 7th iteration (Fig. 3.14d). There are some residual but smaller effects at the end of the 10th iteration (Fig. 3.14e). By the end of the 13th iteration (Fig. 3.14f), the effects of the spikes are almost gone, but five more iterations are needed to meet the convergence criterion. The calculations do not stop until both diversions meet the convergence criterion on the same iteration. In fact, one weir may satisfy the convergence criterion on one iteration but not on a subsequent iteration due to the interaction of the two weirs. The graphs for the final (18th) iteration are shown in (Fig. 3.14g). Even though the convergence tolerance is 7.5%, the differences between the assumed and computed diversion hydrographs drop to 6.8% for the upstream weir and 4.6% for the downstream weir.

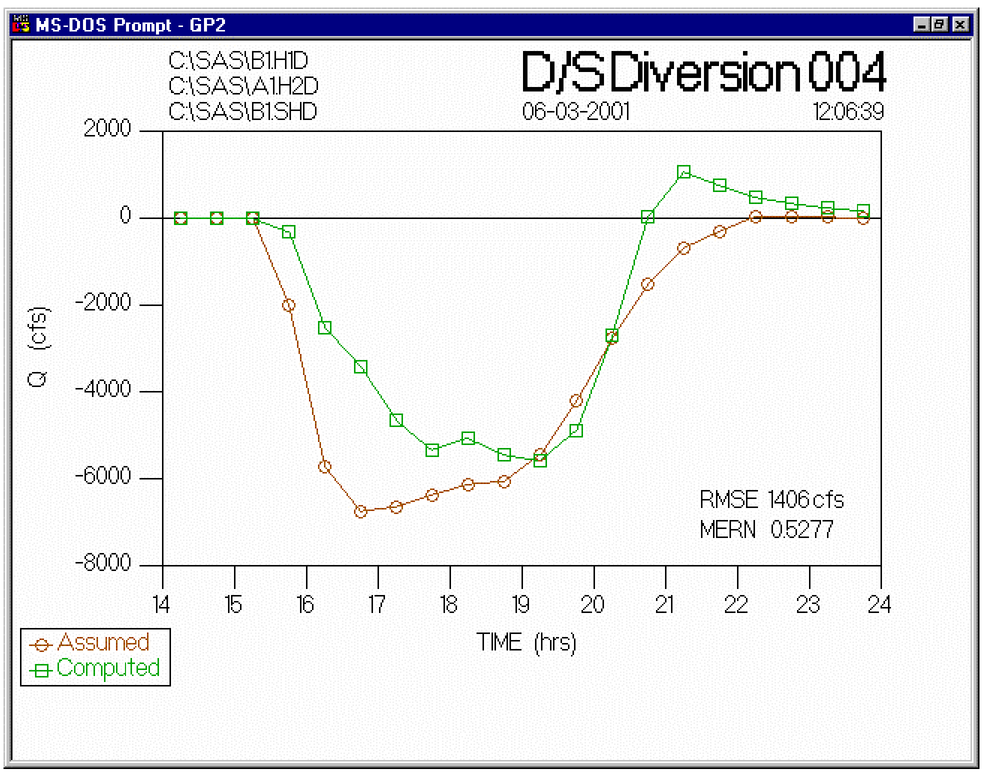




(a) End of first iteration

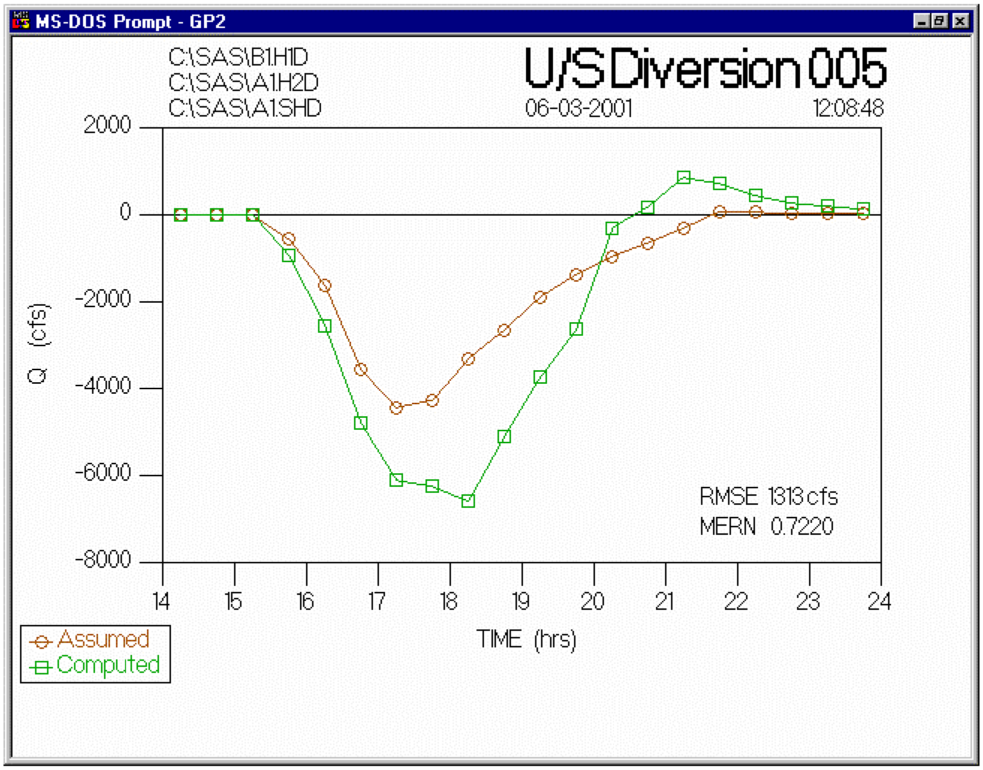
Fig. 3.14 - Plots during the iterations for two weirs

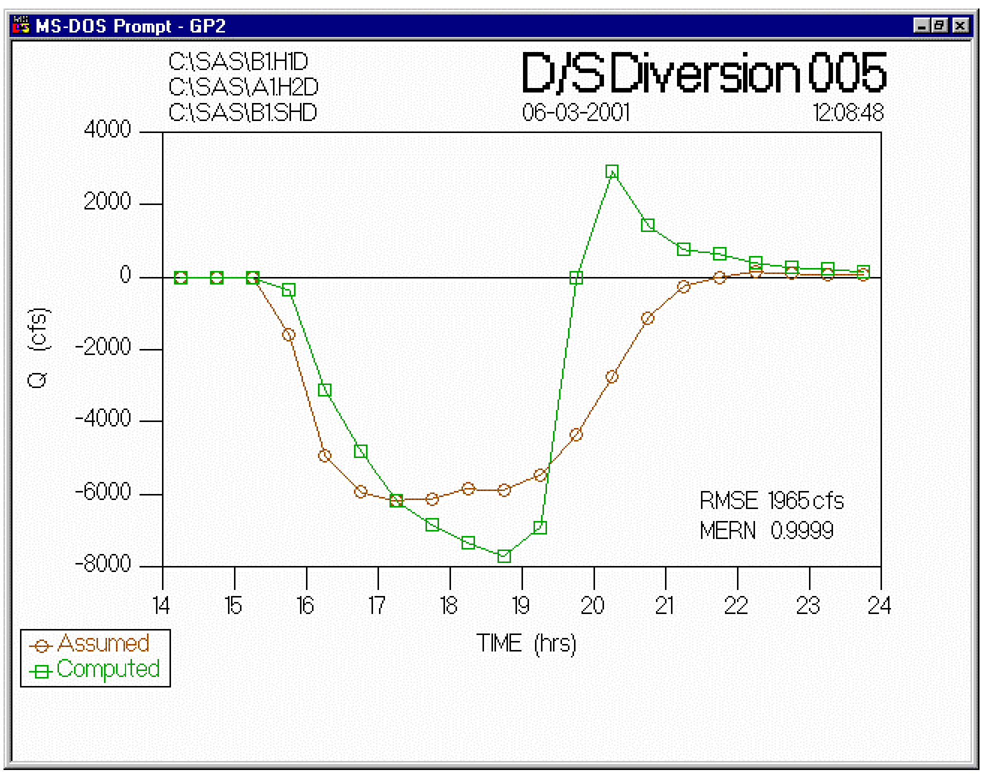




(b) End of 4th iteration

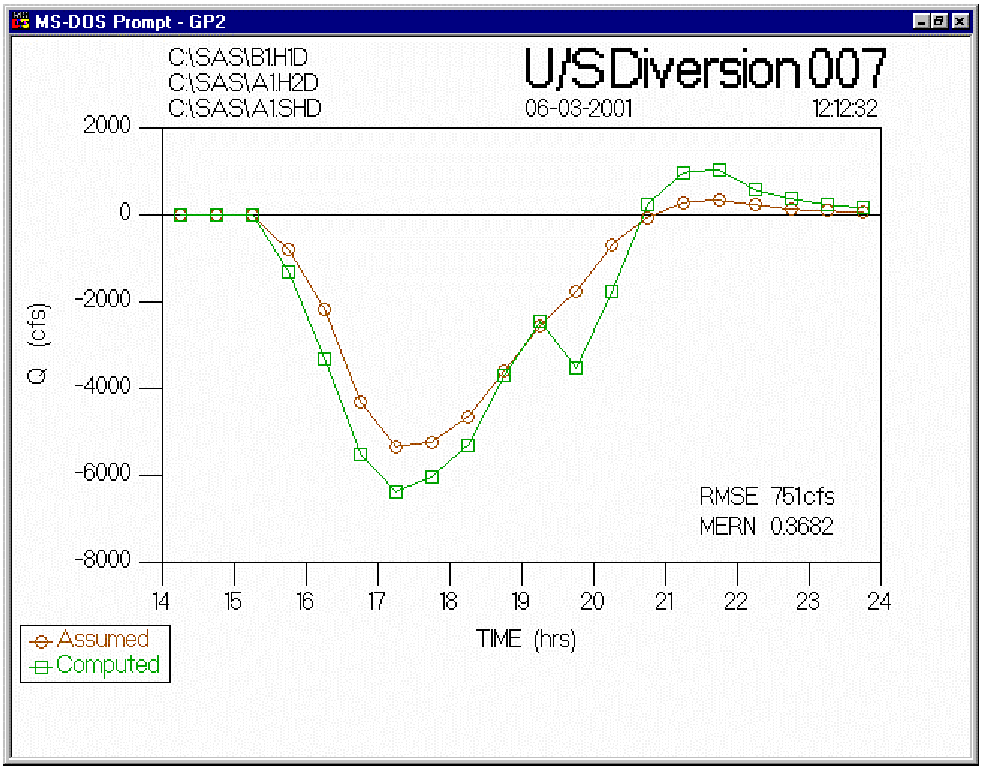
Fig. 3.14 - Plots during the iterations for two weirs (continued)

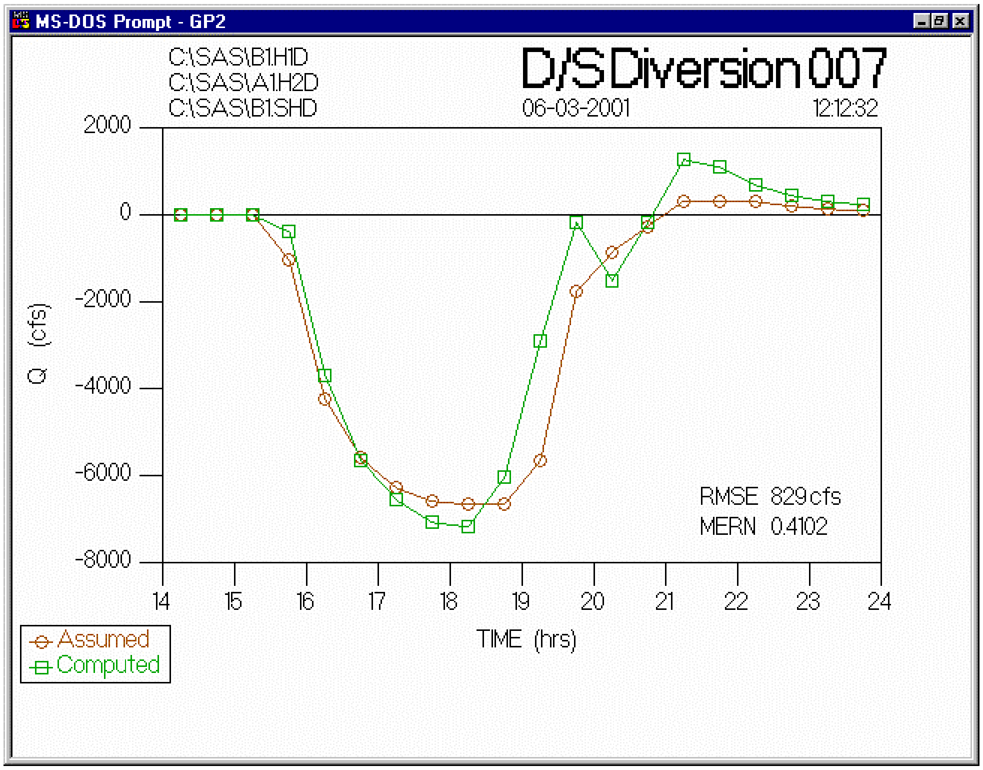




(c) End of 5th iteration

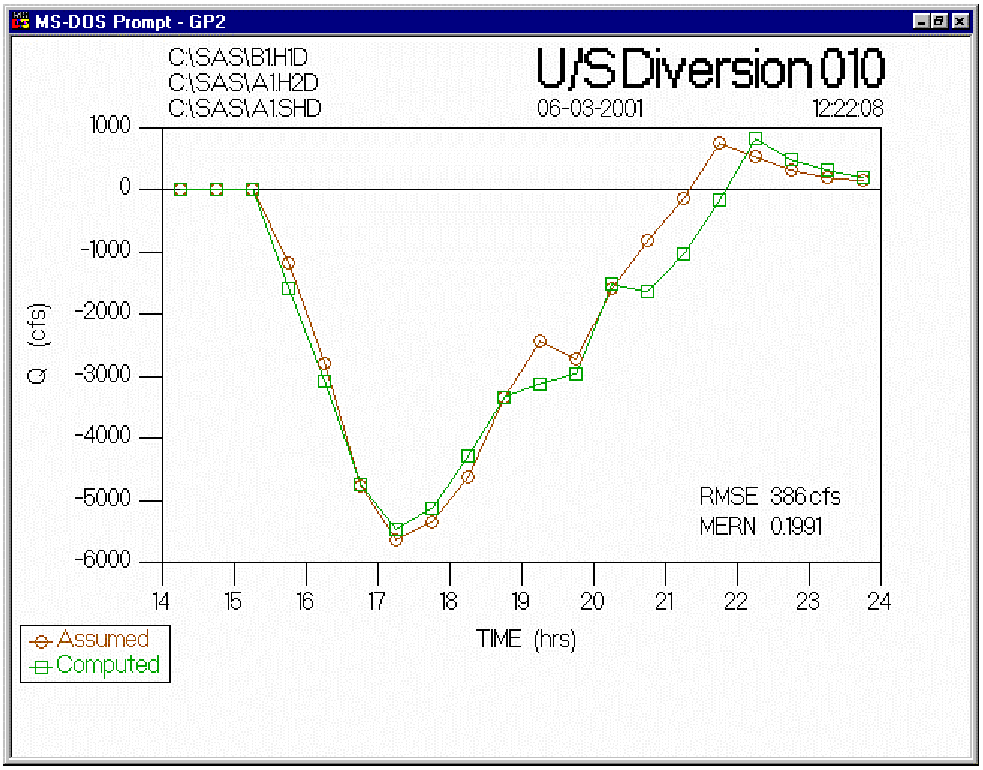
Fig. 3.14 - Plots during the iterations for two weirs (continued)

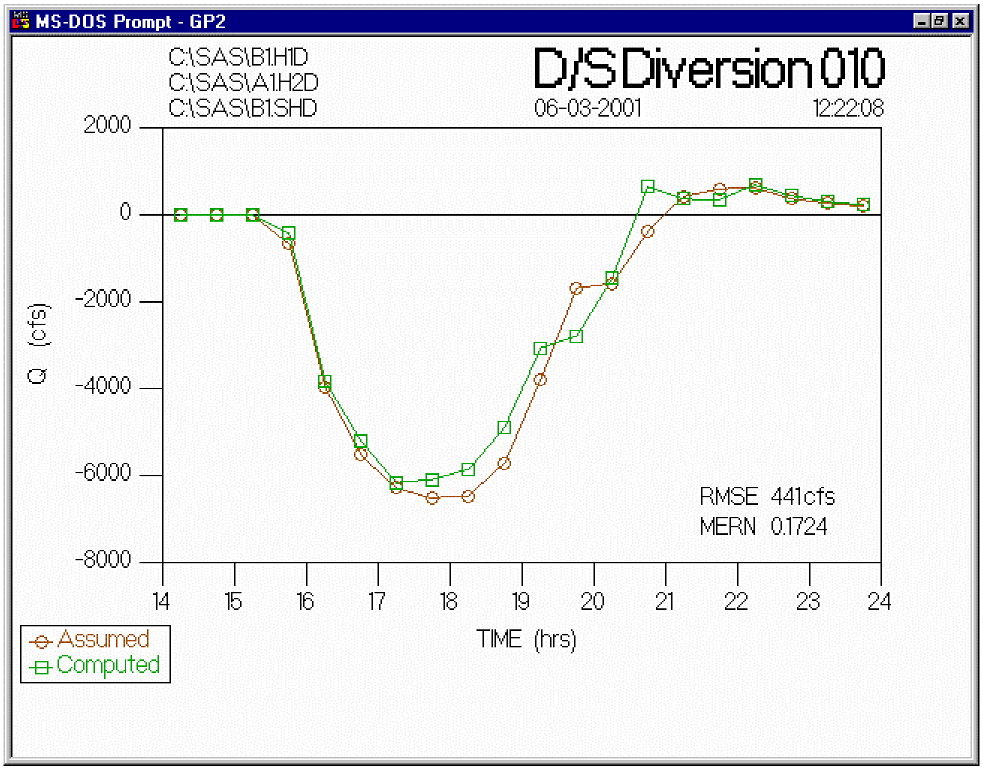




(d) End of 7th iteration

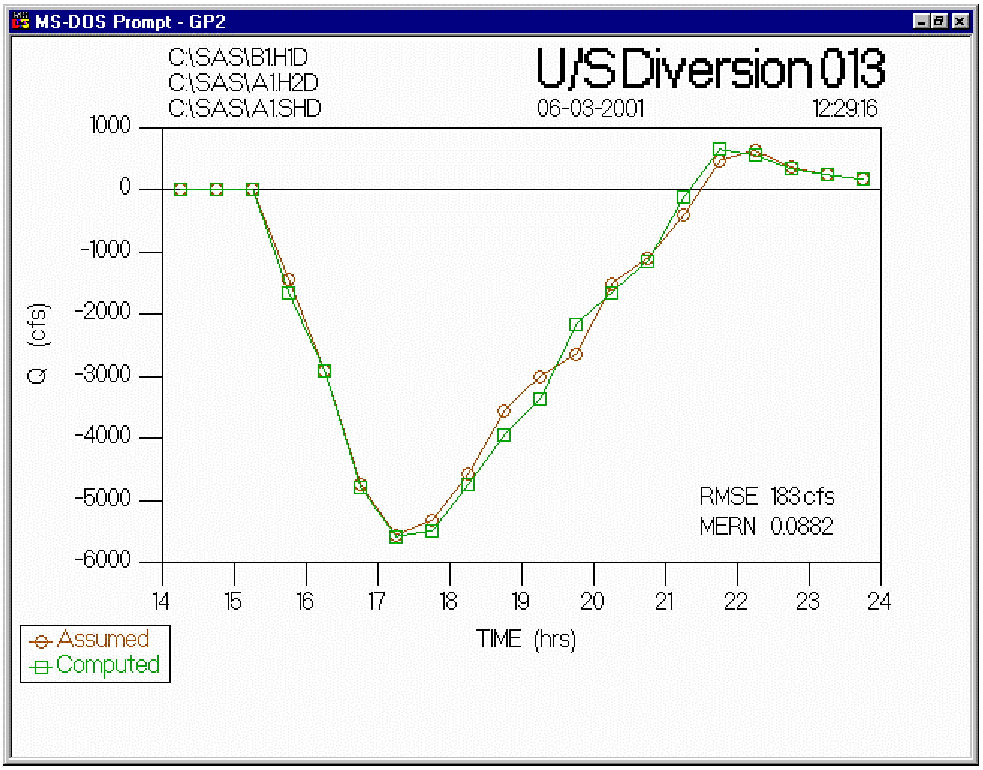
Fig. 3.14 - Plots during the iterations for two weirs (continued)

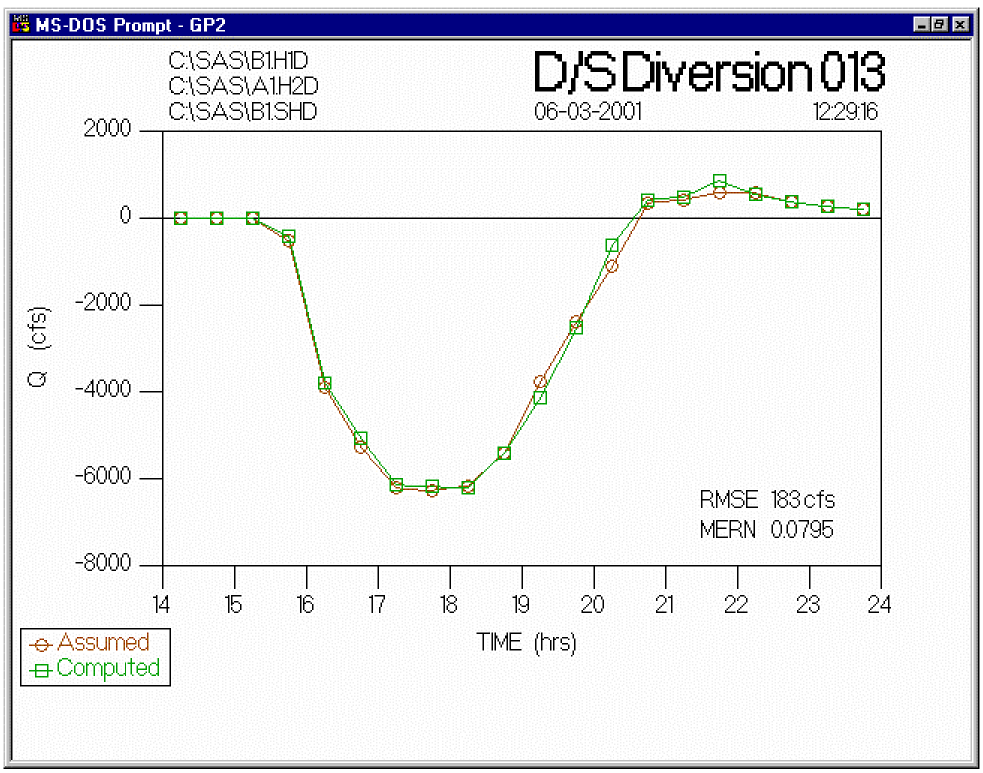




(e) End of 10th iteration

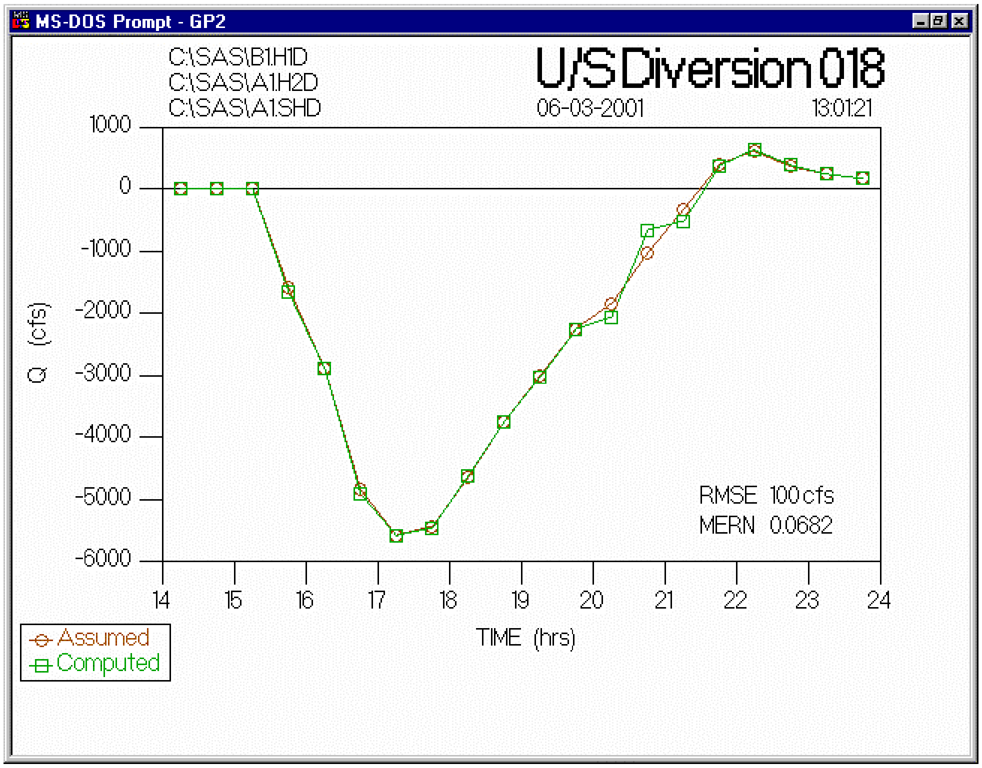
Fig. 3.14 - Plots during the iterations for two weirs (continued)

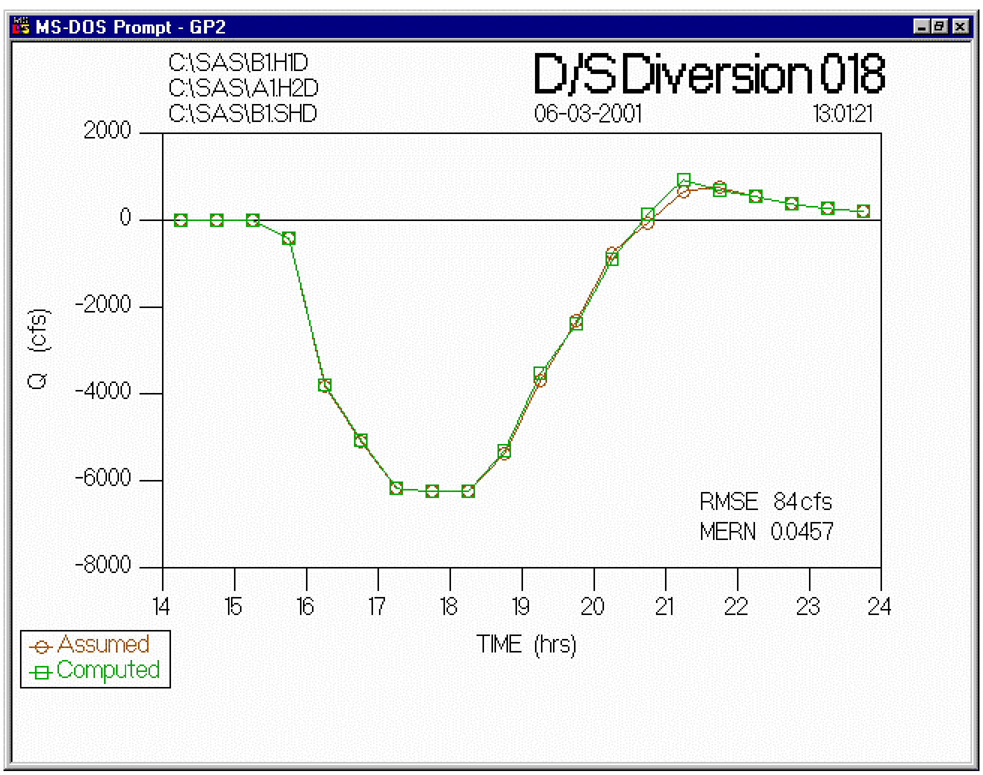




(f) End of 13th iteration

Fig. 3.14 - Plots during the iterations for two weirs (continued)





(g) End of 18th and final iteration

Fig. 3.14 - Plots during the iterations for two weirs (continued)

The summary graphs are shown in Fig. 3.15 and Fig. 3.16. These graphs indicate that the basins may be larger than necessary since the basins do not fill very much above the weir crest and since the reverse flow from the basin back into the channel is very small.

This run required 16 minutes using a DOS window on a 120 MHz computer with a Windows 95 operating system and 6 2/3 minutes on a 900 MHz laptop with Windows 2000.

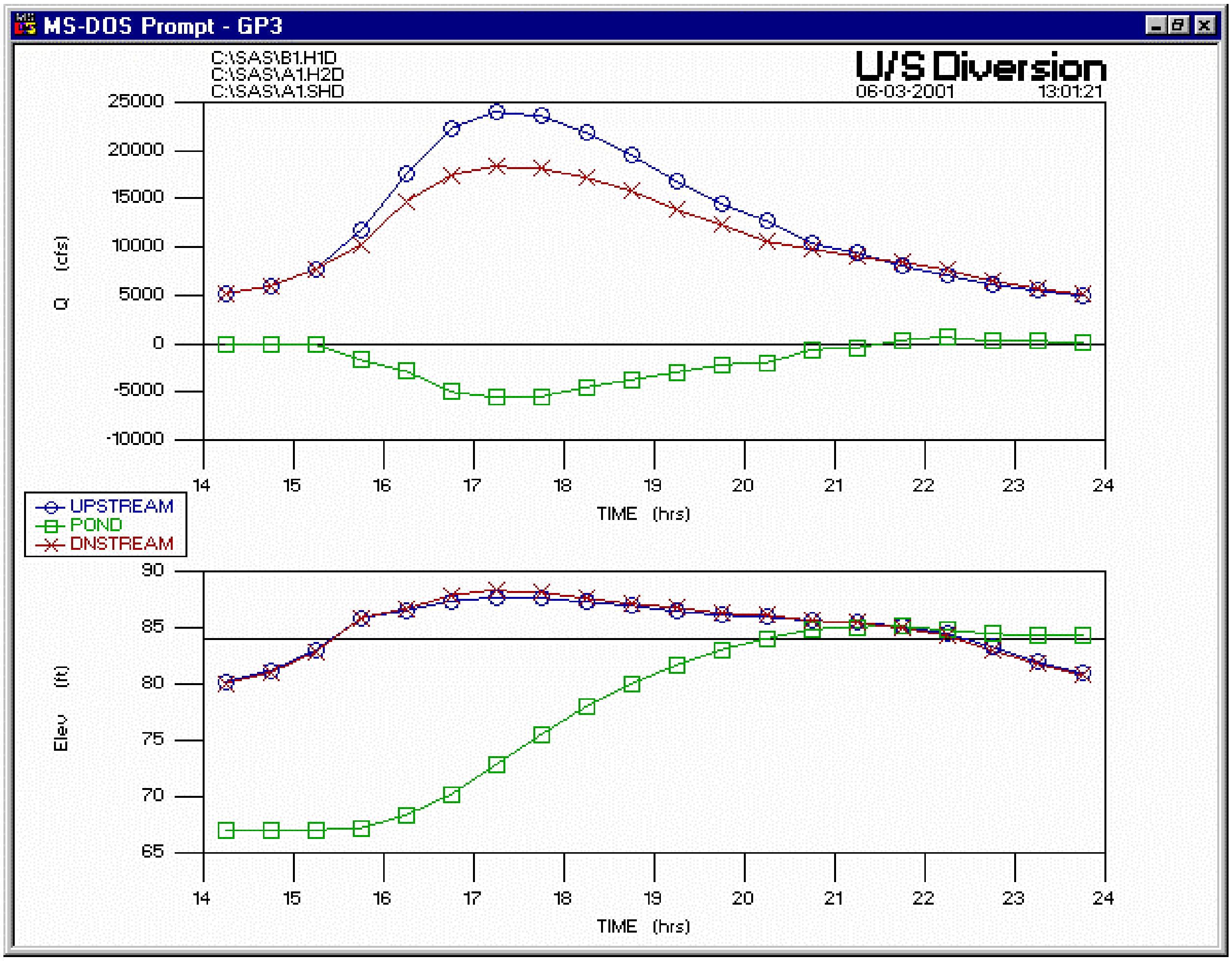


Fig. 3.15 - Final plot for upstream weir for two weir case

3.6.3 - Example with One Set of Diversion Culverts

Example calculations were made with a set of diversion culverts consisting of three 15-ft wide barrels with their inverts 17 ft above the channel invert. The station numbers are in Table 3.1. The input files are in Appendices 6.2.2, 6.2.5, and 6.2.7. The files are basically the same as for the weir in Section 3.6.1 except that the initial estimated diversion in the HEC-1 input file is

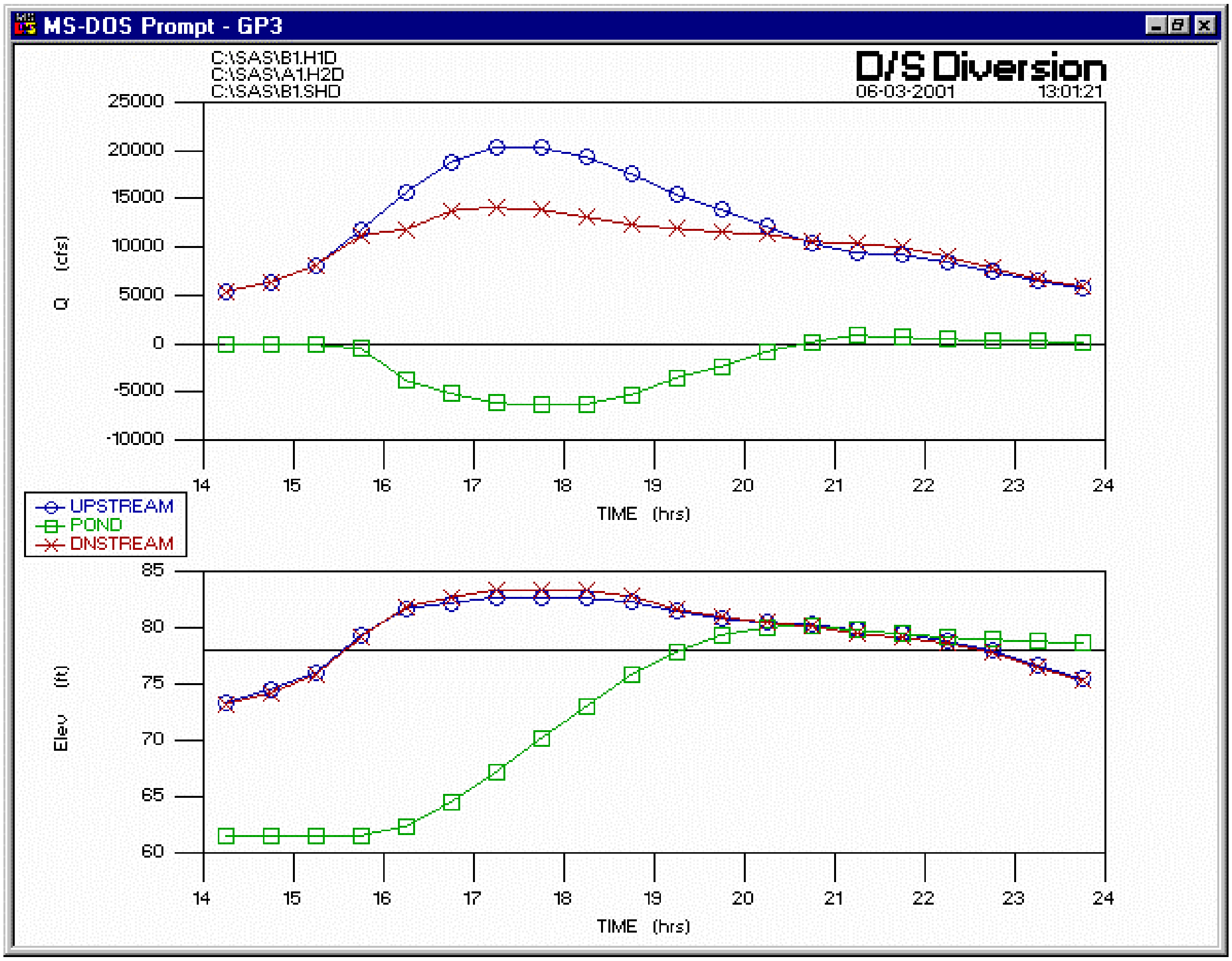


Fig. 3.16 - Final plot for downstream weir for two weir case

Table 3.1 – Stations for Examples with Diversion Culverts

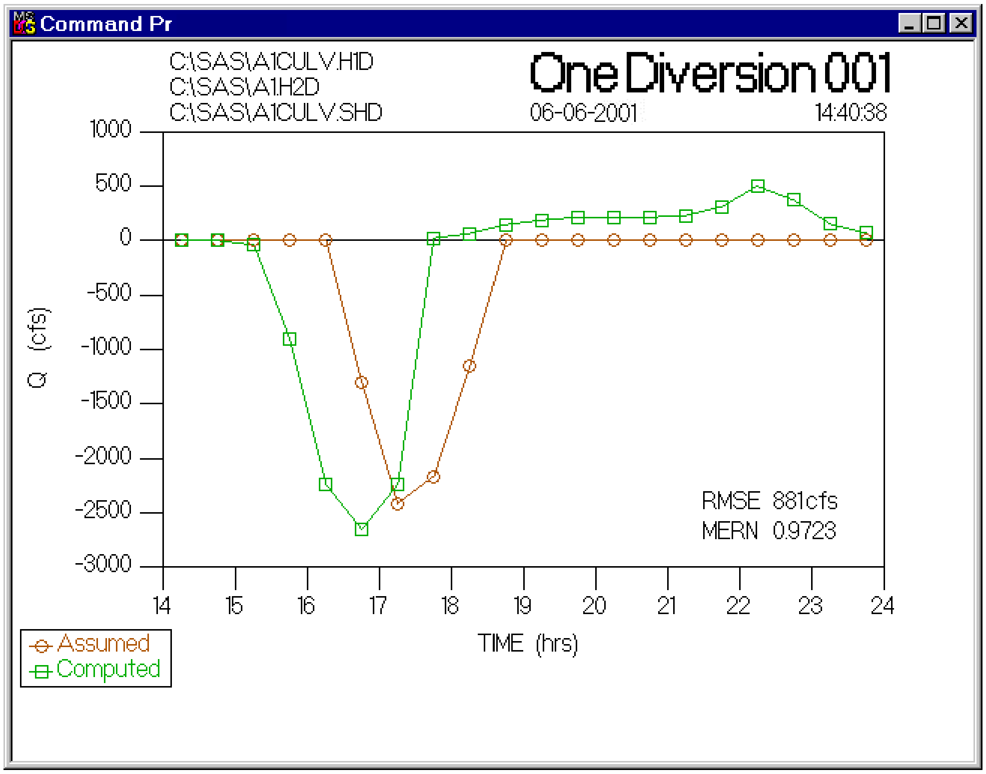
	One Diversion or Upstream Diversion	Downstream Diversion
UPWEIR	85089	76959
ATWEIR	85066	76936
DNWEIR	85042	76912

smaller for the diversion culverts than for the weir and the station numbers were changed to account for the fact that the total width of the culverts is less than the length of the weir crest. Some of the results of the calculations are shown in Fig. 3.17. For the first iteration (Fig. 3.17a), the magnitude of the estimated flow into the basin is approximately correct, but the timing is wrong and the estimated diversion does not have any reverse flow from the basin back into the channel. By the third iteration (Fig. 3.17b), the timing of the calculated diversion is getting closer to that for the assumed diversion. The assumed and calculated diversions get progressively closer together until the convergence tolerance is satisfied on the 10th iteration (Fig. 3.17d). The final results are shown in Fig. 3.18. These results indicate that the basin is too small because it has almost reached its maximum storage by the time of the peak of the hydrograph in the channel. As a result, the maximum diversion rate occurs before the peak of the hydrograph and the reduction in the flow rate at the peak of the hydrograph is smaller than the reduction prior to the peak.

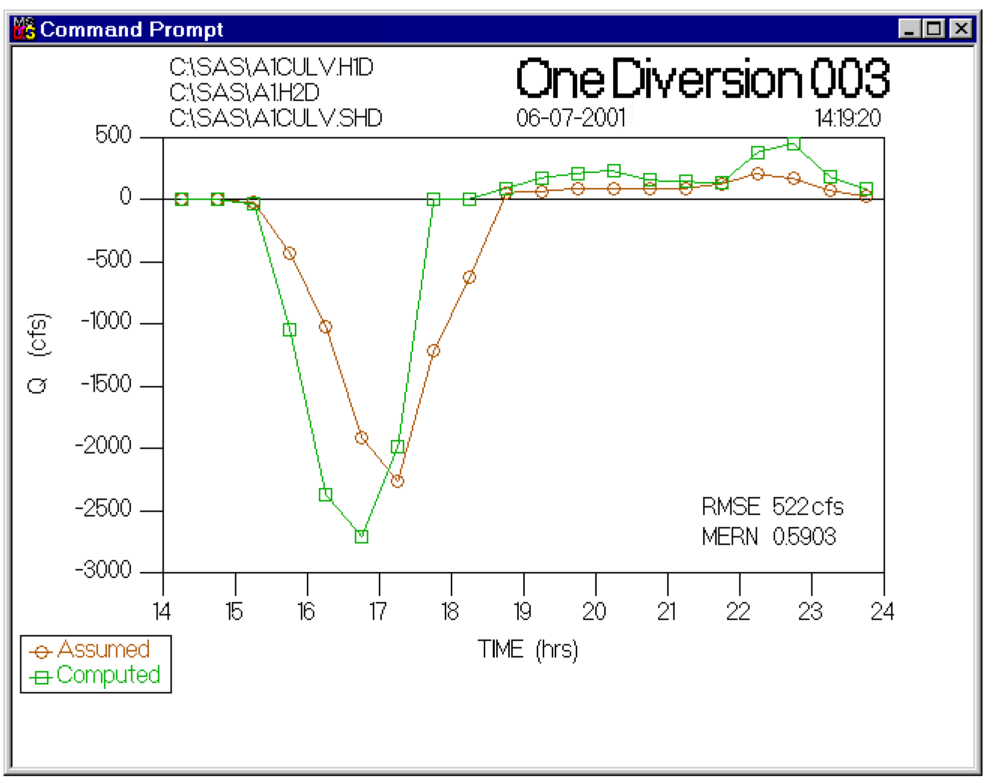
The calculations for diversion culverts are significantly slower than for weirs, primarily because of using THYSYS (Section 2.2.2.4) for the reverse flow calculations. The calculations for the results shown in Fig. 3.17 and Fig. 3.18 required 33 minutes running in a DOS window under Windows NT on a 300 MHz computer. Because of the longer computational time on the slower computers, the time for each time step in SIDEHYD for diversion culverts is written to the screen so the progress of the calculations can be monitored. The computational time was 2 3/4 minutes on a 900 MHz Pentium III laptop with Windows 2000.

3.6.4 - Example with Two Sets of Diversion Culverts

Example calculations were made with two sets of diversion culverts. Each set consisted of three 15-ft wide barrels with their inverts 17 ft above the channel invert. The input files are in Appendices 6.2.4, 6.2.5, 6.2.7, and 6.2.10. The files are basically the same as for the weirs in Section 3.6.2 except that the initial estimated diversion in the HEC-1 input file is smaller for the diversion culverts than for the weirs and the station numbers were changed to account for the fact that the total width of the culverts is less than the length of the weir crests. Some of the results of the calculations are shown in Fig. 3.19. For the first iteration (Fig. 3.19a), the magnitude of the estimated flow into the upstream basin is approximately correct, but there is more than a factor of two difference in the assumed and calculated maximum flow rate into the downstream basin. Six iterations are required (Fig. 3.19b) before the magnitudes of the assumed and calculated maximum diversion rates are approximately the same for the downstream diversion. Fig. 3.19b also illustrates that, contrary to the previous calculations for both weirs and culverts, convergence occurs first for the later times for the downstream diversion. The assumed and calculated diversions get progressively closer together until the convergence tolerance is satisfied on the 15th iteration (Fig. 3.19c). The final results are shown in Fig. 3.20 and Fig. 3.21. The maximum diversion for the upstream culverts occurs at approximately the time of the peak flow rate in the channel. However, the maximum stage and therefore the maximum diversion flow for the downstream culverts occur after the peak flow in the channel.

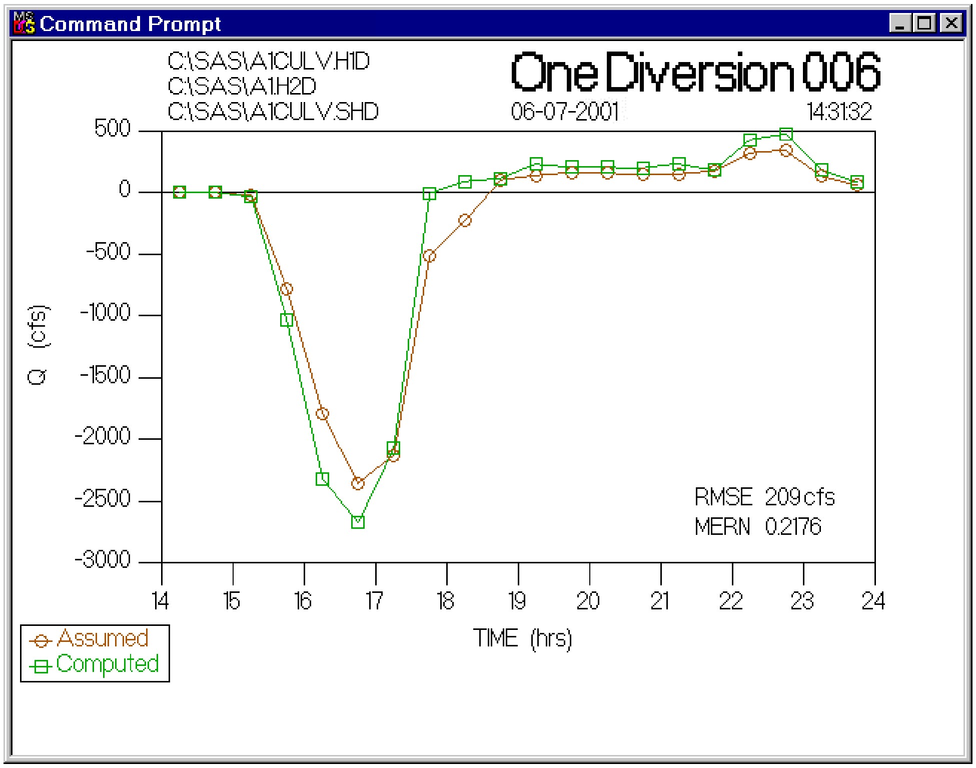


(a) End of 1st iteration

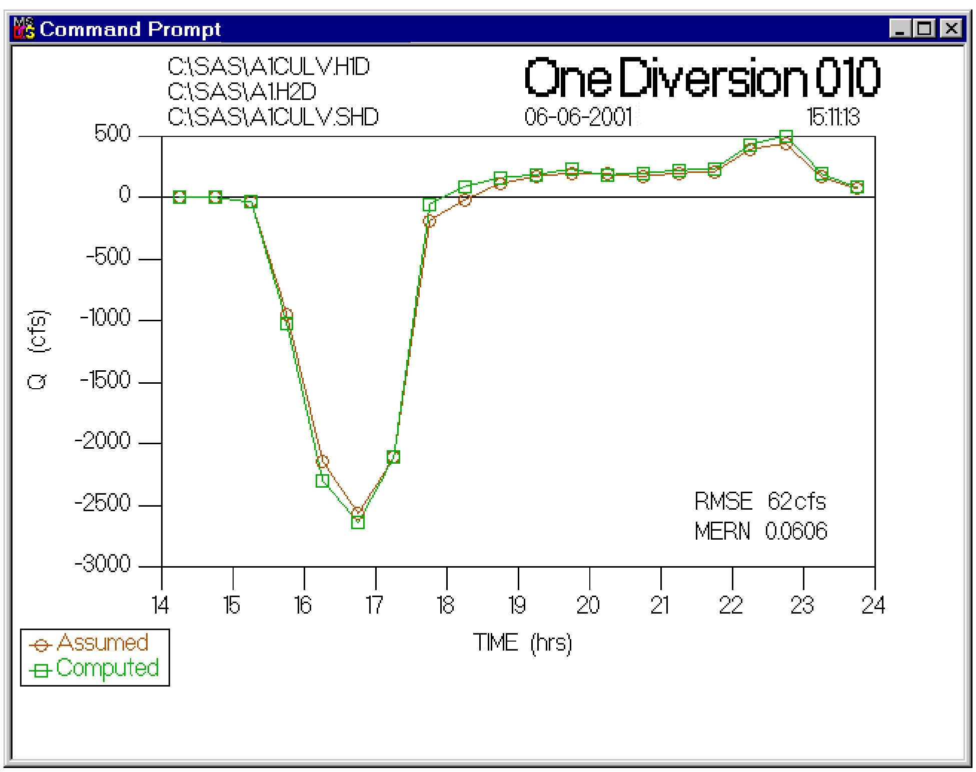


(b) End of 3rd iteration

Fig. 3.17 - Plots during the iterations for one set of diversion culverts



(c) End of 6th iteration



(d) End of 10th and final iteration

Fig. 3.17 - Plots during the iterations for one set of diversion culverts (continued)

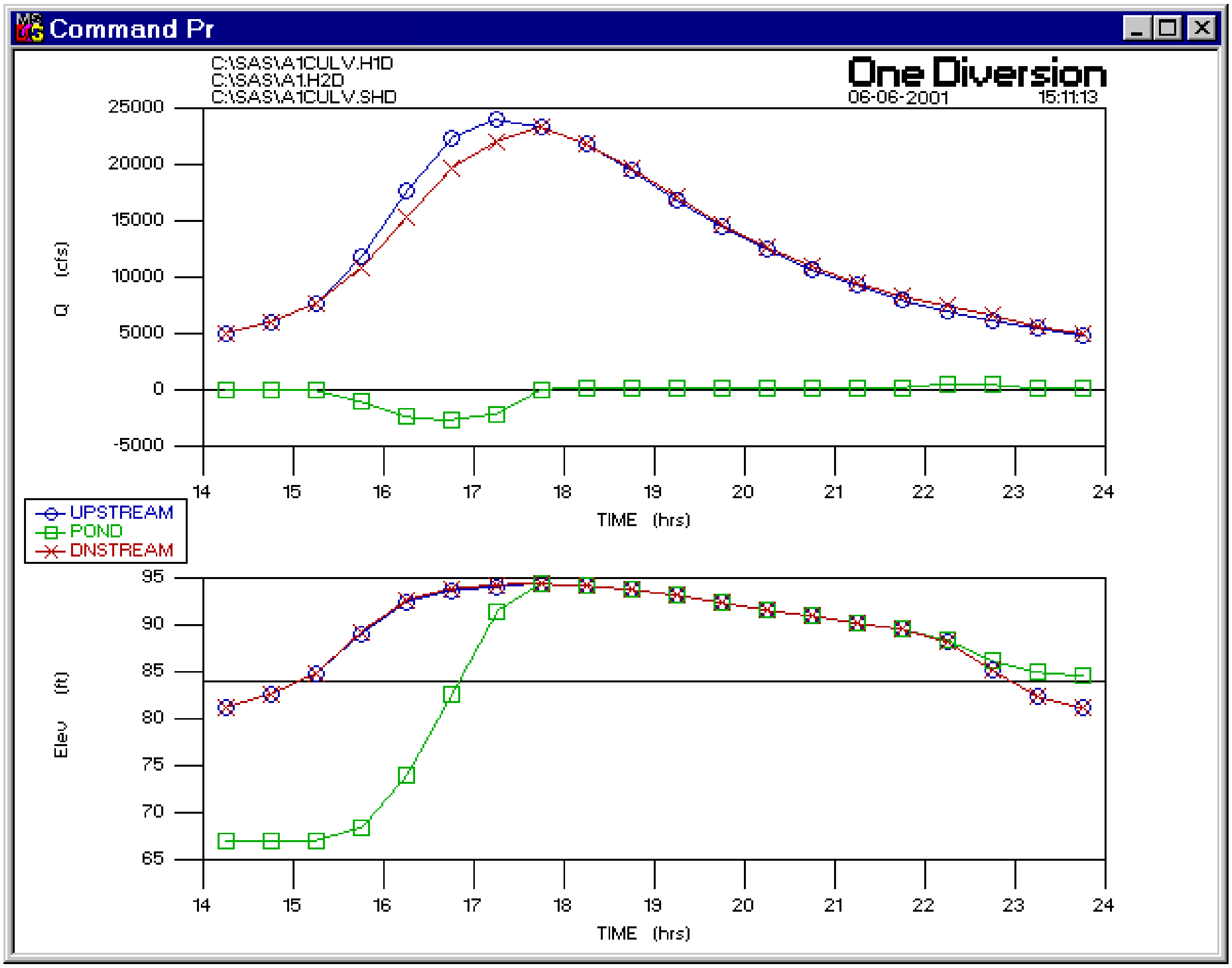
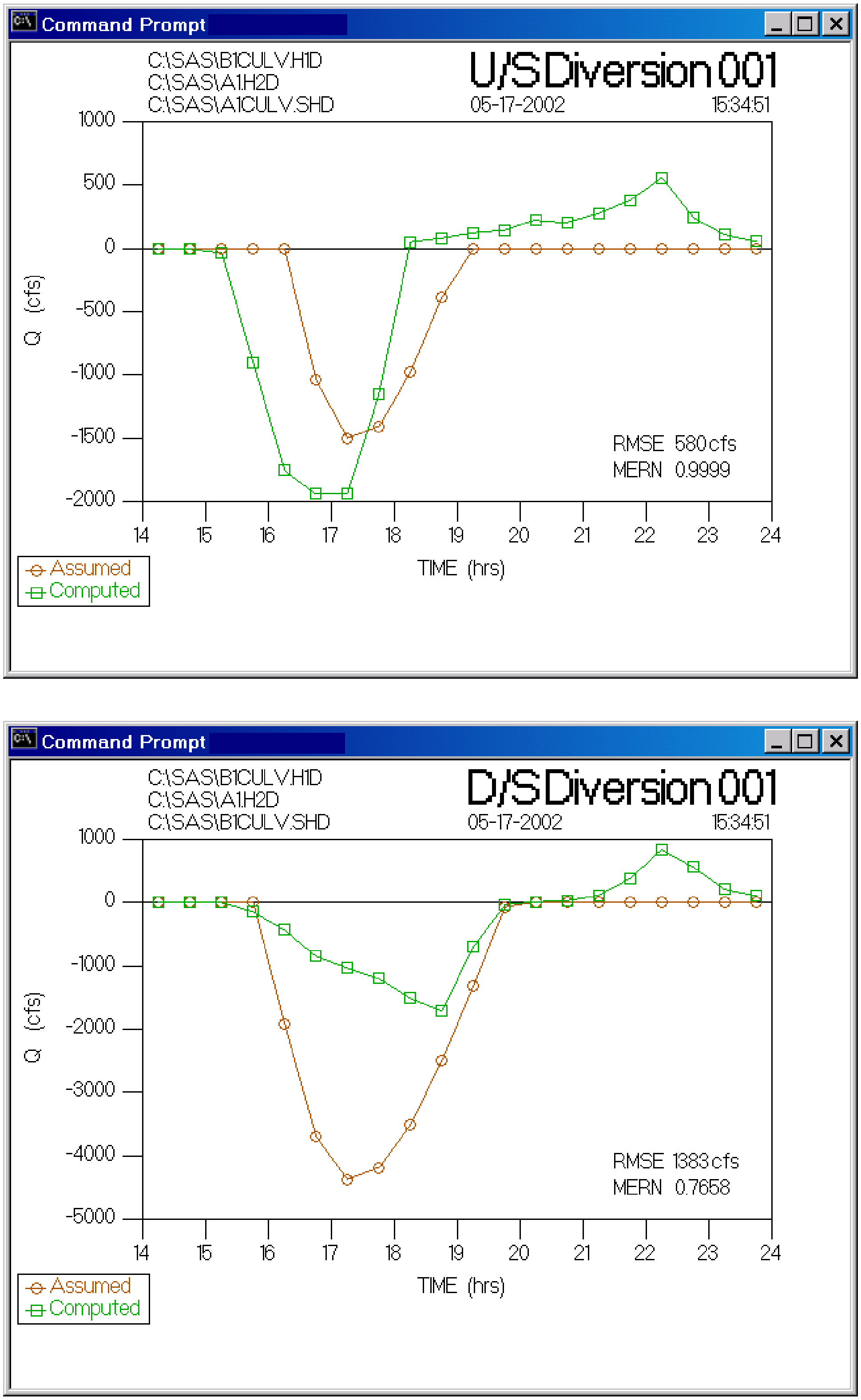


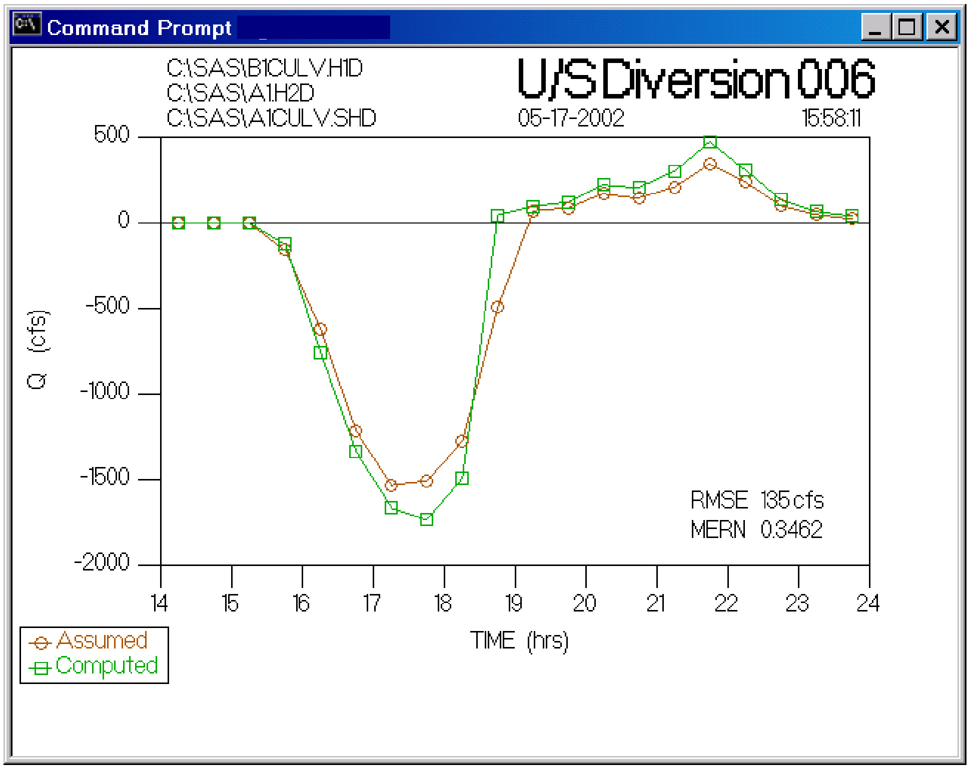
Fig. 3.18 - Final plot for culverts for one diversion case

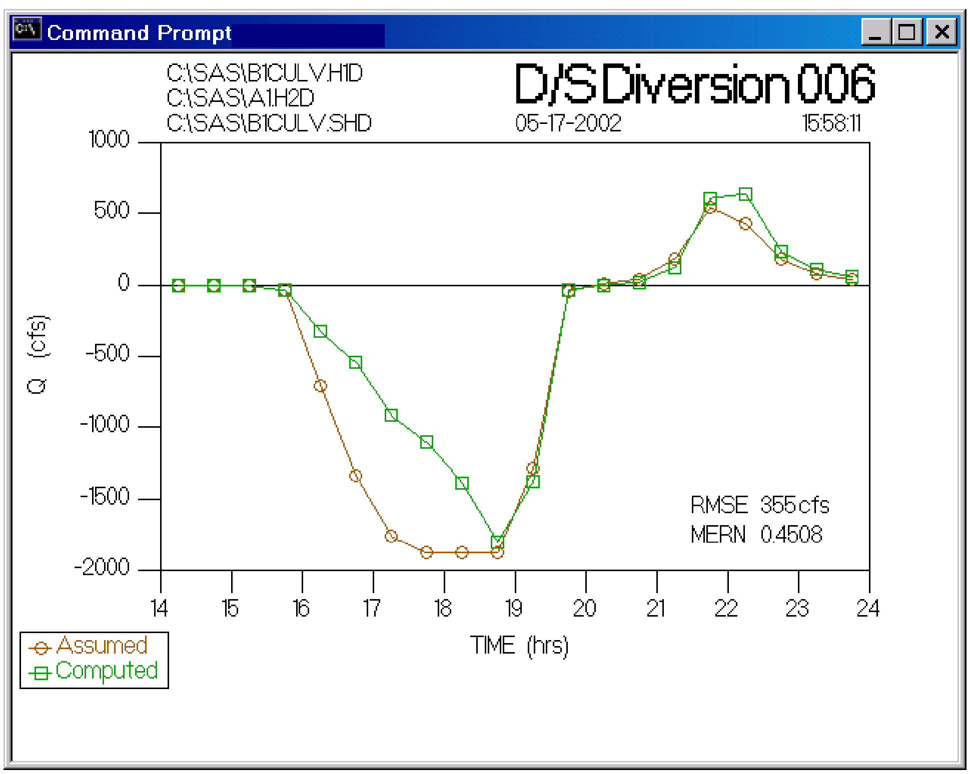
The calculations for the 15 iterations for the two sets of diversion culverts required 1 hour 25 minutes running in a DOS window under Windows NT on a 300 MHz computer. The computational time was reduced to 55 minutes for nine iterations by improving the initial estimate of the diversion in the HEC-1 base input file for the downstream set of culverts. The corresponding time was 10 min on a 900 MHz Pentium III laptop with Windows 2000.



(a) End of 1st iteration

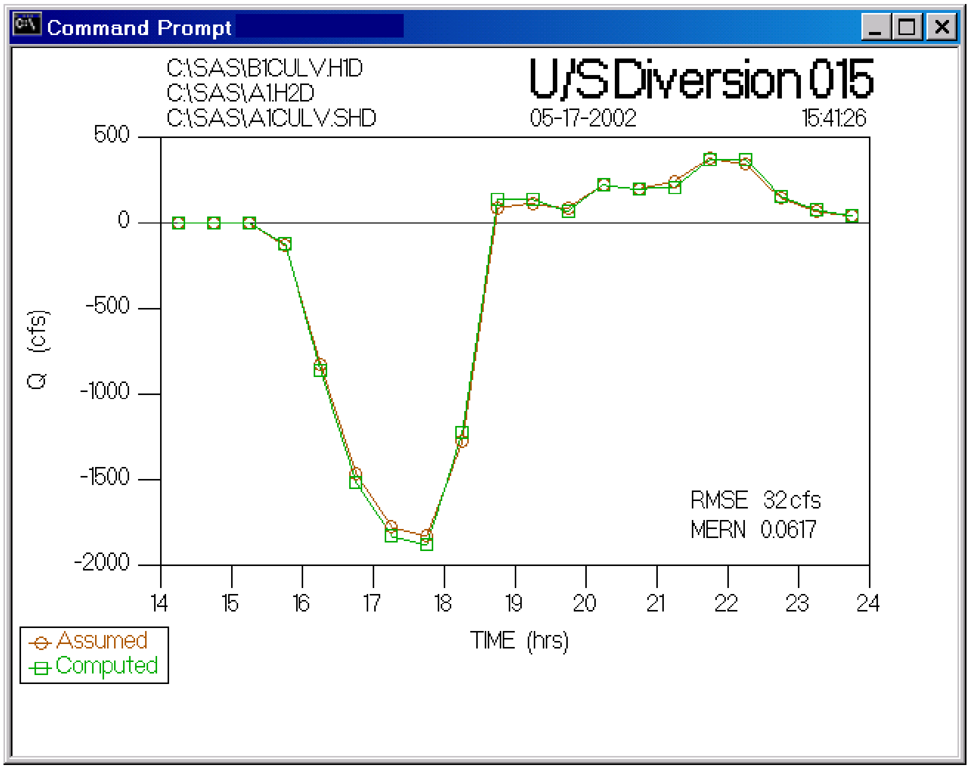
Fig. 3.19 - Plots during the iterations for two sets of diversion culverts

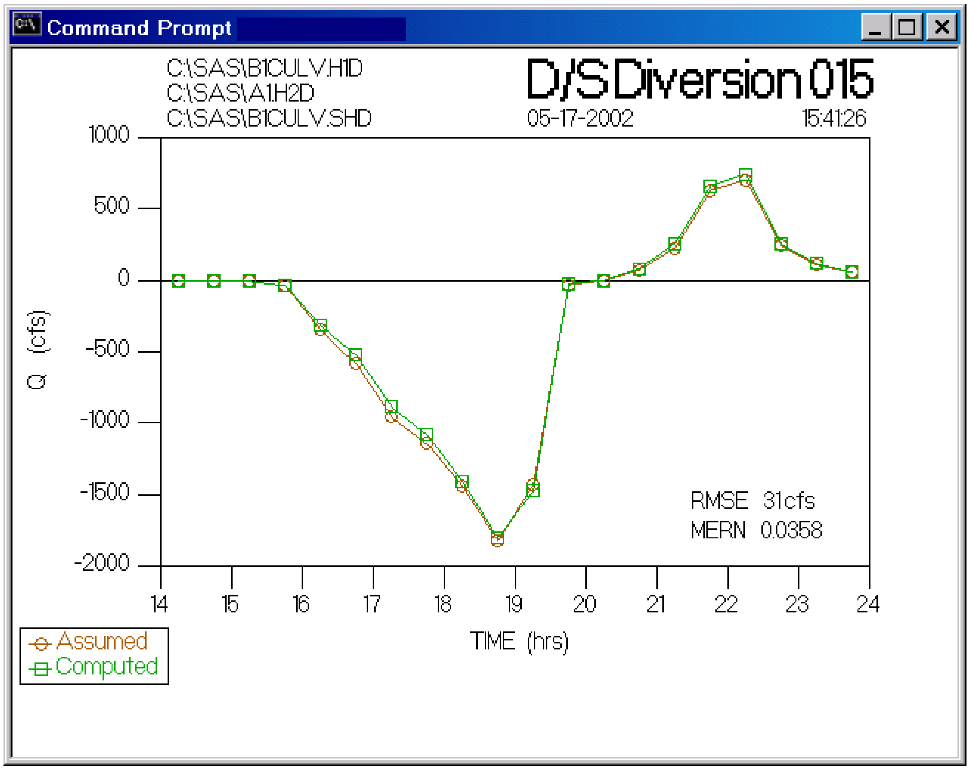




(b) End of 6th iteration

Fig. 3.19 - Plots during the iterations for two sets of diversion culverts (continued)





(b) End of 15th and final iteration

Fig. 3.19 - Plots during the iterations for two sets of diversion culverts (continued)

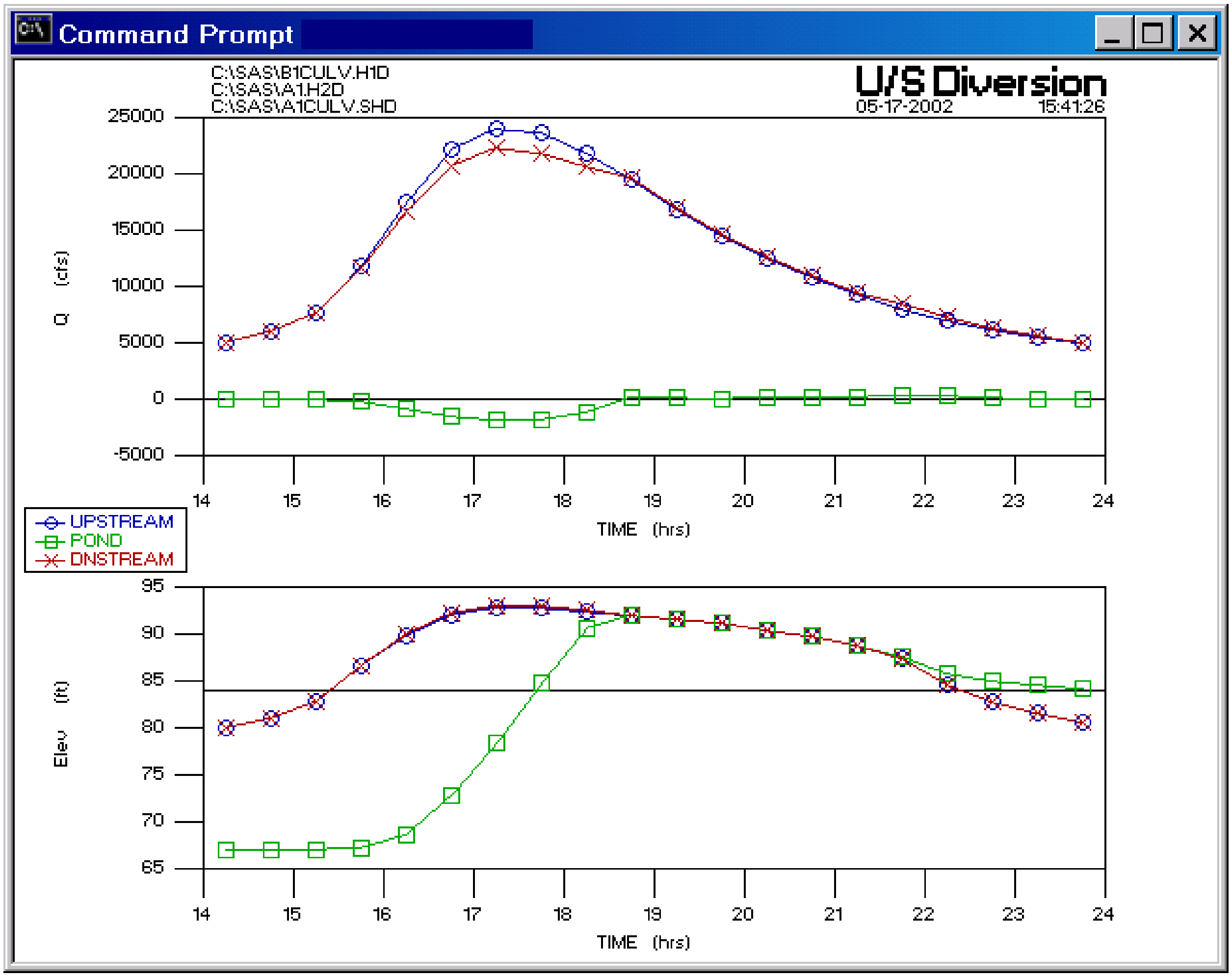


Fig. 3.20 - Final plot for upstream culverts for two diversion case

3.7 - WARNINGS AND ERROR MESSAGES

The programs that comprise the Side-Diversion Analysis System generate error and warning messages to the screen and to the output files when calculations do not proceed as expected. The messages from HEC-1 and HEC-2 are described in the User's Manuals (Section 3.2) for those programs. Error messages and warning messages from the other programs are described below. Error messages are fatal to program execution, and the problems that cause them must be rectified before further processing can take place. Warning messages indicate that an assumption was made to allow processing to continue. There are also informational messages. The user is strongly urged to closely inspect the output files (Section 3.5.3) from all of the programs that issue errors or warnings in order to assure that the assumptions and consequent answers are realistic.

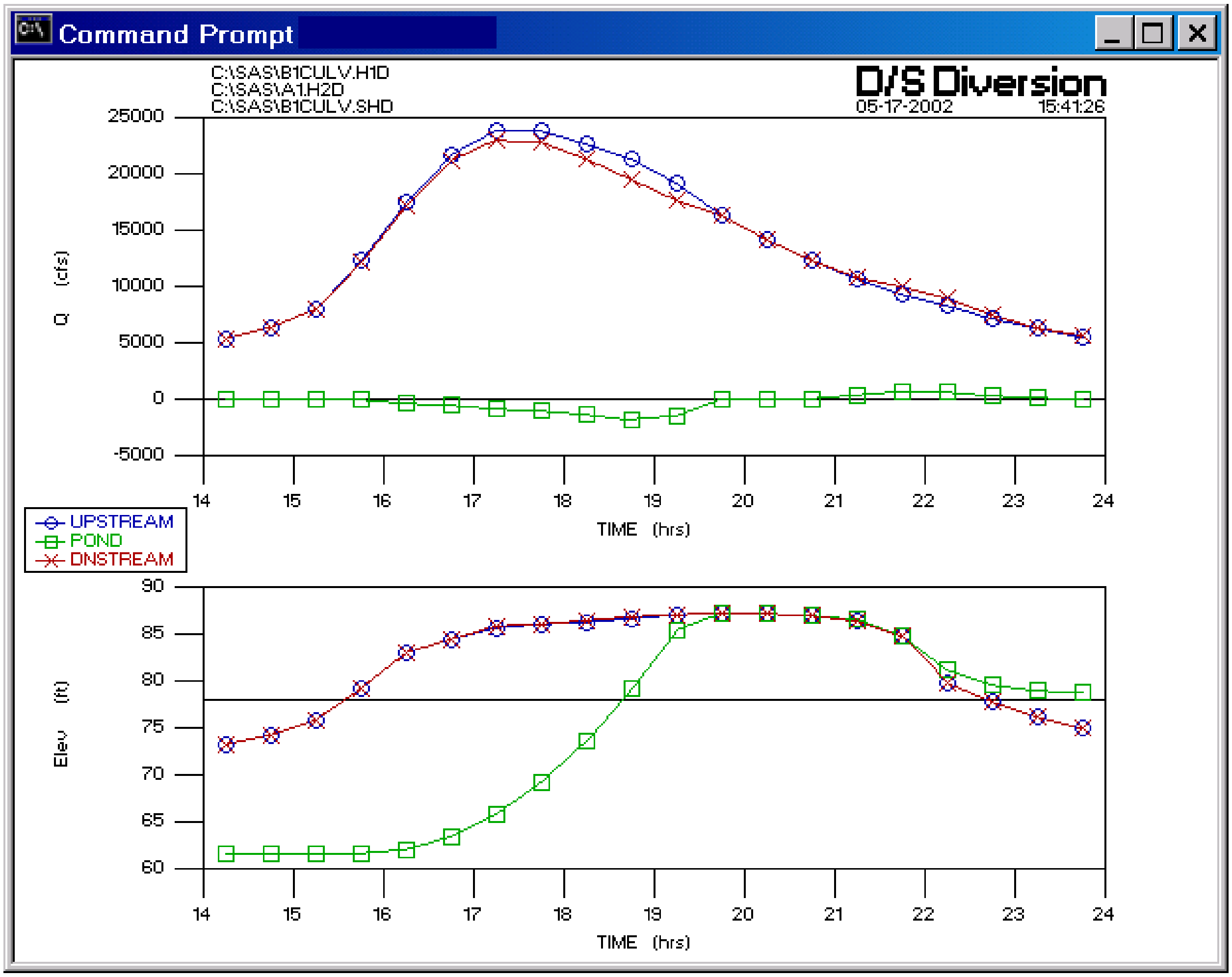


Fig. 3.21 - Final plot for downstream culverts for two diversion case

`WARNING 90`: Depth in culvert less than critical. value1 value2

During the gradually varied flow calculations for forward flow through diversion culverts, the calculated depth was found to be less than critical. This situation should not occur unless the specified diversion culvert slope (CLSLOPE) corresponds to a steep slope. Check the value of CLSLOPE in the base SIDEHYD input file. In the calculations, the depth is set equal to the critical depth.

`WARNING 93`: CRITICAL FLOW. value1 value2 value3 value4 value5 value6
Source: SIDEHYD.FOR

Flow at critical depth is occurring in the channel along the weir diversion structure. This warning does not necessarily mean that there is an error in the inputs or in the computations since this situation can actually exist in the channel. Nevertheless, the programs cannot account for this condition. Value1 is the computational time step. Value2 is the distance step along the weir crest. Value3 is the time. Value4 is the depth at the downstream end of the weir. Value5 is the depth along the weir crest. Value6 is the downstream discharge.

WARNING 114: CHANNEL TO BASIN FLOW EQUATIONS ARE VALID ONLY FOR SIDE SLOPES BETWEEN 2.5H:1V AND 4H:1V
Source: SIDEHYD.FOR

The side slope specified in the SIDEHYD input data file is outside the range of 2.5 to 4. The empirical equations used to model flow into the basin are based on experiments using physical models with 2.5H:1V and 4H:1V side slopes.

WARNING 138: BASIN WATER SURFACE ELEVATION ABOVE MAX. INPUT ELEV. value1 value2
Source: SIDEHYD.FOR

The computed water surface elevation for the basin is greater than the input area-elevation data. Value1 is the computed water surface elevation in the basin and value2 is the maximum elevation specified in the area-elevation table. For basin water levels above the highest input value, the basin volume is determined by assuming that the sides of the pond extend vertically upward. If this assumption is invalid, the error can be rectified by providing additional data in the SIDEHYD base data file.

ERROR 151: DIMENSION EXCEEDED. NLO > 10.
Source: SIDEHYD.FOR

The program is limited to no more than 10 drainage culverts per basin. To eliminate this error, reduce the number of culverts specified in the SIDEHYD base data file or change the dimension statement for the variables RWSTA, CDIA, CHFA, CWFA, CLFA, CIFA, and COFA in SIDEHYD and recompile the program.

ERROR 152: DIMENSION EXCEEDED. NSTEP+2*NDSTEP+1 > 102.
Source: SIDEHYD.FOR

The program is limited to 102 DX steps for gradually flow along the diversion structure. To correct this error, reduce the specified NSTEP or the specified NDSTEP in the SIDEHYD base data file. Alternatively, increase the dimensions of the variables: Q, Y, XLEN, QDSTR, YDSTR, TSTR, VPD, APD, and YPD in SIDEHYD and recompile (but this later approach should not be needed).

ERROR 153: DIMENSION EXCEEDED. NCOMP > 9502
Source: SIDEHYD.FOR

The program is limited to 9502 time steps in the analysis. To eliminate this problem, specify a larger TSTEP in the SIDEHYD base data file or increase the dimensions of the variables QLL, QUR, YUR, QDR, YDR, TR, QWR, PDVOL, PDY in SIDEHYD and recompile.

ERROR 154: TIDEFLEX VALVES NOT ALLOWED ON BOX CULVERTS
Source: SIDEHYD.FOR

Tideflex valves are made only for circular pipes. No provision is made in the program to model box culverts equipped with Tideflex valves. The input file for SIDEHYD needs to be changed.

WARNING 155: NUMBER OF DIVERSION CULVERT BARRELS > 3
Source: SIDEHYD.FOR

The program is limited to 3 adjacent diversion culvert barrels (in place of a weir) for side diversion of flow since only 2 and 3 barrels were tested experimentally. To eliminate this problem, reduce the ANBBL specified in the SIDEHYD base data file.

ERROR 191: NO HYDROGRAPH AT UPWEIR
Source: MOH2DF1.FOR

The post-processing program could not identify a hydrograph in the file RETRHYD.OUT corresponding to the specified UPWEIR station. Verify that

(1) the UPWEIR station number is specified correctly in the User Interface,
(2) the UPWEIR station number is specified correctly in the HEC-1 base data file, and
(3) HEC-1 will execute the base data file independent of SAS and produce an output hydrograph for this station.

ERROR 198: ITIME JTIME Value1 Value2
Source: MOH2DF1.FOR

The Hydrograph Threshold intercepts are outside of the dimensions of HEC-1 hydrograph discharges, 1 through 300. Value1 is the time when the flow first equals or exceeds the threshold. Value2 is the last time ordinate when the flow equals or exceeds the threshold. To eliminate this error

(1) execute HEC-1 independently of SAS,
(2) inspect the hydrograph output at the UPWEIR station, and
(3) redefine the Hydrograph Threshold discharge.

WARNING 256: ENERGY EQUATION FOR YU IN CULVERT DIVERSION DNC. YUMAX-YUMIN(FT) = value FOR LAST TRIAL
Source: SIDEHYD.FOR

The flow depth at the upstream end of the diversion culverts is found by trial and error. This warning means that the trial and error process did not converge. The difference in the maximum and minimum values of the trail range is printed. This difference will normally be very small. This type of error normally occurs when critical depth exists, so the upstream depth is set to the critical depth. ‘DNC’ means ‘Did Not Converge’.

MESSAGE 259: FORWARD FLOW BASIN LEVELS DNC. SET TIME STEP(HR) TO value.
Source: SIDEHYD.FOR

The program automatically reduced the calculation time interval in an effort to obtain stable calculations for flow into the basin. 'DNC' means 'Did Not Converge'.

MESSAGE 260: REVERSE FLOW ITERATIONS DNC. SET TIME STEP(HR) TO value.
Source: SIDEHYD.FOR

The program automatically reduced the calculation time interval in an effort to obtain stable calculations for reverse flow from the basin into the channel. 'DNC' means 'Did Not Converge'.

WARNING 264: TRIAL QWs FOR CULVERT DIVERSION DNC. QMAX-QMIN(CFS) = value1 DIFF. IN TRIAL & CALC. HW(FT) = value2

Forward flow through diversion culverts is determined by trial and error (bisection) calculations. If these trials do not converge, this warning is written and the flow is taken to be the average of the upper and lower limits for the last trial. The difference in the upper and lower limits is value1. Value2 is the difference in the trial and calculated headwater values for the last trial.

WARNING 270: EMPIRICAL RESULTS NOT APPLICABLE FOR SUBMERGED DIVERSION CULVERTS. HW = value1 FT 1.2*HEIGHT = value2 FT

The headwater (HW, value 1) is greater than 1.2 times the height of the diversion culverts (value2). This condition leads to submerged flow, but the empirical results used for forward flow through the diversion culverts are not valid for submerged flow.

ERROR 810: THYSYS CULVERT FLOW DNC. CCTOL HWX-HWC
Source: SIDEHYD.FOR

The iterative calls to the THYSYS calculations for drainage culverts or for reverse flow through diversion culverts did not converge (DNC). Value1 is the maximum number of iterations. Value2 is the difference between the trial and calculated headwater. Value 3 is the convergence tolerance. After the maximum number of iterations, the program prints this message, averages the maximum and minimum trial discharges, and continues.

ERROR 812: NO HYDROGRAPH AT UPWEIR
Source: MOH1DF.FOR

The post-processing program could not identify a hydrograph in the file RETRHYD.OUT corresponding to the user-specified UPWEIR station. Verify that

(1) the UPWEIR station number is specified correctly in the User Interface,
(2) the UPWEIR station number is specified correctly in the HEC-1 base data file, and

(3) HEC-1 will execute the base data file independently of SAS and produce an output hydrograph for this station.

ERROR 822: ATWEIR STATION NOT FOUND
Source: MOH1DF.FOR

The post-processing program could not locate a hydrograph in the file RETRHYD.OUT corresponding to the user-specified ATWEIR station. Verify that

(1) the ATWEIR station number is specified correctly in the User Interface,
(2) the ATWEIR station number is specified correctly in the HEC-1 base data file, and
(3) HEC-1 will execute the base data file independently of SAS and produce an output hydrograph for this station.

WARNING 855: FORWARD-FLOW BASIN LEVELS DNC. YBAS2-YBAS1(FT) value1 > value2.
Source: SIDEHYD.FOR

The program iterates to solve for discharge into the basin and water surface elevations in the basin. If this iteration has not closed to within a specific tolerance after 25 iterations, the upper and lower values are averaged to proceed with computations. Value1 is the difference used to determine if the stopping criterion has been met. Value2 is the tolerance. 'DNC' means 'Did Not Converge'.

WARNING 860: SEPARATION ZONE MOMENTUM. (QW1-QW)/QD value1 > value2.
Source: SIDEHYD.FOR

The program iterates to solve for the water surface elevation and the discharge at the upstream end of the separation zone downstream of the diversion structure. If this iteration has not closed to within a specific tolerance after 25 iterations for a diversion, the upper and lower values are averaged to proceed with computations. Value1 is the normalized difference used to determine if the stopping criterion has been met. Value2 is the tolerance.

WARNING 861: QW > 0.6 * QU IN FINAL SOLUTION.
Source: SIDEHYD.FOR

The diverted flow is greater than 60 percent of the upstream flow. This condition is beyond the range of the physical model experiments that were run to develop the empirical relationships used in the computational model.

WARNING 870: REVERSE-FLOW BASIN LEVELS DNC. YBAS2-YBAS1(FT) HCCONV(FT) value1 - value2 > 0.01
Source: SIDEHYD.FOR

SIDEHYD iterates to solve for discharge out of the basin and water surface elevations in the basin. If this water surface elevation in the basin has not closed to within the specified tolerance after 20 iterations, this message is printed, the upper and lower values are averaged, and computations proceed. Value1 is the difference between the trial and calculated basin water levels. Value2 is the additional head change in the channel for reverse flow from the basin into the channel. Tolerance is 0.01 ft. This situation may occur when the head difference between the basin and the channel is very small, so the computational error is normally very small even if this situation occurs. 'DNC' means 'Did Not Converge'.

WARNING 995: TIDEFLEX TAILWATER ENERGY DNC

The energy equation is solved by trial to obtain an tailwater for a drainage culvert with no check valve that is equivalent to (i.e., gives the same flow as) the culvert with a Tideflex valve. This trial calculation did not converge (DNC). The value is taken as the last trial value, and the calculations proceed.

WARNING 1009: TAILWATER ENERGY DNC. CULVERT FULL. TW BELOW SOFFIT.
Source: SIDEHYD.FOR

The energy equation for the equivalent tailwater depth to account for a flap gate on a pipe culvert cannot be solved by iteration due to computational singularity at this depth. This message is printed, the upper and lower values are averaged, and computations proceed. 'DNC' means 'Did Not Converge'.

WARNING 1109: TAILWATER ENERGY DNC. CULVERT FULL. TW BELOW SOFFIT.
Source: SIDEHYD.FOR

The energy equation for the equivalent tailwater depth to account for a flap gate on a box culvert cannot be solved by iteration due to computational singularity at this depth. This message is printed, the upper and lower values are averaged, and computations proceed. 'DNC' means 'Did Not Converge'.

3.8 - TROUBLE SHOOTING

The Side-Diversion Analysis System is composed of batch processes that, unlike an executable program, continue to run even if the previous step has encountered a fatal error. The problem becomes apparent when subsequent programs are not able to find the input data necessary for proper execution. When this problem occurs, processing can be stopped by typing:

'Ctrl-Break'

Depending on the location in the execution sequence, multiple tries may be required to stop the execution. The DOS Operating System will respond with the message:

Terminate batch job (Y/N) ?

Respond to this prompt affirmatively, and then issue the command:

CLEAN

to clear the directory of the intermediate files and script files that were produced during the aborted run. CLEAN.BAT is the batch file listed blow:

```
@DEL *.OU?
@DEL MOH2DF2.D*
@DEL H2CON.D*
@DEL *.PL?
@DEL *.HS?
@DEL D??
@DEL TAPE*.*
@DEL ZZ*.*
@DEL SCRIPT?.BAT
```

At this time it is prudent to check that

(1) the directory for the executable HEC-1 and HEC-2 programs is in the PATH.

(2) the filenames for all base data files were entered correctly.

(3) the base data files will execute without error outside of SAS. HEC-1, HEC-2, and SIDEHYD should run properly with only the base data files as input.

Finding all of the above in order, the user may discover the source of the error by single stepping through the batch processes in the following manner.

(1) CLEAN the directory as described above.

(2) Enter GO in the SAS directory to start the User Interface of the Side-Diversion Analysis System.

(3) Enter the filenames, station numbers, and Hydrograph Threshold.

(4) EXIT from the User Interface.

This action will return the user to the DOS Prompt. At this point a batch file named SCRIPT0.BAT has been created, but not invoked. The SCRIPT0.BAT file is identical to the file that would have been created and invoked automatically had the user selected CALC on the User Interface, except that SCRIPT0.BAT does not invoke SCRIPT2.BAT as its last command (i.e., it does not continue the execution of SAS). Therefore, by typing:

SCRIPT0

at the DOS Prompt, the process will execute through the first batch steps and stop. The results of these steps may be inspected to assure their proper production and termination. At this point a new batch file, SCRIPT2.BAT, has been created. If the problem has not yet appeared, edit the SCRIPT2.BAT file to delete the line containing SCRIPT3.BAT. This command would send control to SCRIPT3.BAT, continuing the process without pause. By deleting this command, exiting from the editor, and typing:

SCRIPT2

at the DOS Prompt, the process will execute through the next set of batch steps and stop. Once again, the results may be inspected to assure proper execution. A new batch file, SCRIPT3.BAT, will have been created, and as before, it will be necessary to delete the line containing SCRIPT2.BAT. Then, by typing:

SCRIPT3

at the DOS Prompt, the next batch steps are executed. The results may be inspected to check for proper execution. The SCRIPT3 process produces a new SCRIPT2.BAT file. Once again, the SCRIPT2.BAT file must be edited to eliminate the line containing SCRIPT3.BAT if the user wishes to proceed in step fashion.

The Side-Diversion Analysis System reproduces a SCRIPT2.BAT and a SCRIPT3.BAT file for each iteration until the stopping criteria are met. By deleting the lines containing these names from the batch files, the automatic transfer of control to the next batch file is eliminated. By executing the batch files manually, the user will eventually discover the point at which failure occurred. Inserting a line with the word PAUSE immediately after each executable statement in the batch file will provide additional time for viewing any on-screen messages. System error messages and program output files (Section 3.5.3) may then be inspected to find the characteristics and cause of the failure.

Although it would be rather tedious, the same type of procedure can be used even for properly operating files to obtain the intermediate output files that the various program delete in the normal operation of SAS. The desired files should be copied. The copies should be renamed or moved into another directory if it is desired to continue running SAS since it requires the intermediate output files. Do not delete or rename the files in the SAS directory.

4 - PROGRAMMER'S MANUAL

4.1 - SYSTEM OVERVIEW

The Side-Diversion Analysis System (SAS) consists of a Visual Basic User Interface, a set of flow simulation programs, a set of pre-processor programs to reformat data and control execution, and two graphics programs to display results. Processing begins with execution of the User Interface. This interface allows the user to specify base data files for the major programs and to identify key station numbers for connecting the simulations to each other.

4.1.1 - One Diversion

Fig. 4.1 and Table 4.1 give the sequence of steps for an analysis for one diversion (one weir or one set of adjacent diversion culverts). Square brackets around filenames in this chapter indicate the names of user-specified base data files.

The procedure begins when the user enters GO at the DOS prompt in the directory C:\SAS. This command invokes the batch file named GO.BAT that executes the User Interface, which is called SAS.EXE. Filenames, station numbers, and the Hydrograph Threshold discharge are entered into the form displayed by the User Interface (Fig. 3.10 or Fig. 3.11). SAS.EXE transcribes these values into the file CNTRL.DAT and creates a batch file named SCRIPT1.BAT for the first iteration in the trial and error calculations. Control is transferred to SCRIPT1.BAT, which executes HEC1.EXE using the base data file specified by the user. Post-processing of the HEC1.OUT file by RETRHYD.EXE is followed by execution of three pre-processors (MOH2DF0.FOR, MOH2DF1.FOR, and MOH2DF2.FOR), which assemble and reformat the data from the user-specified HEC-2 base data file and the corresponding hydrographs in the RETRHYD.OUT file into one or more HEC-2 input files. Next, and still under the control of SCRIPT1.BAT, a program named CNTRL.EXE is executed to compose the SCRIPT2.BAT batch file. The last command in the SCRIPT1.BAT file turns control over to SCRIPT2.BAT.

SCRIPT2.BAT executes HEC2.EXE n times (Section 3.5.3) using the data files MOH2DF2.D01 through MOH2DF2.Dn producing HEC-2 output files named D01 through Dn. Execution of HEC-2 is followed by post-processing of the output files by MOH2OF.EXE to collect the water surface profile information calculated for the DNWEIR station. This information is put into a file named MOH2OF.OUT. The program MOSWDF.EXE combines information in the user-specified SIDEHYD base data file with the HEC-2 output in MOH2OF.OUT to create the SIDEHYD input file, which is called MOSWDF.OUT. SIDEHYD.EXE is executed and the files SIDEHYD.OUT and SIDEHYD.PLT are created. Then the program MOH1DF. EXE produces an updated HEC-1 input file and a batch file named SCRIPT3.BAT. The graphic display program, GP2.EXE, is executed next. The last command in SCRIPT2.BAT turns control over to SCRIPT3.BAT.

The SCRIPT3.BAT file will be in one of two standard forms. If the stopping criteria are not met, SCRIPT3.BAT re-executes HEC1.EXE using for input the newly created data file, MOH1DF.OUT. If the stopping criteria are met, i.e. if the trial and calculated diversions agree within the specified tolerance, the SCRIPT3.BAT file executes the final graphic program, GP3.EXE, and exits to DOS.

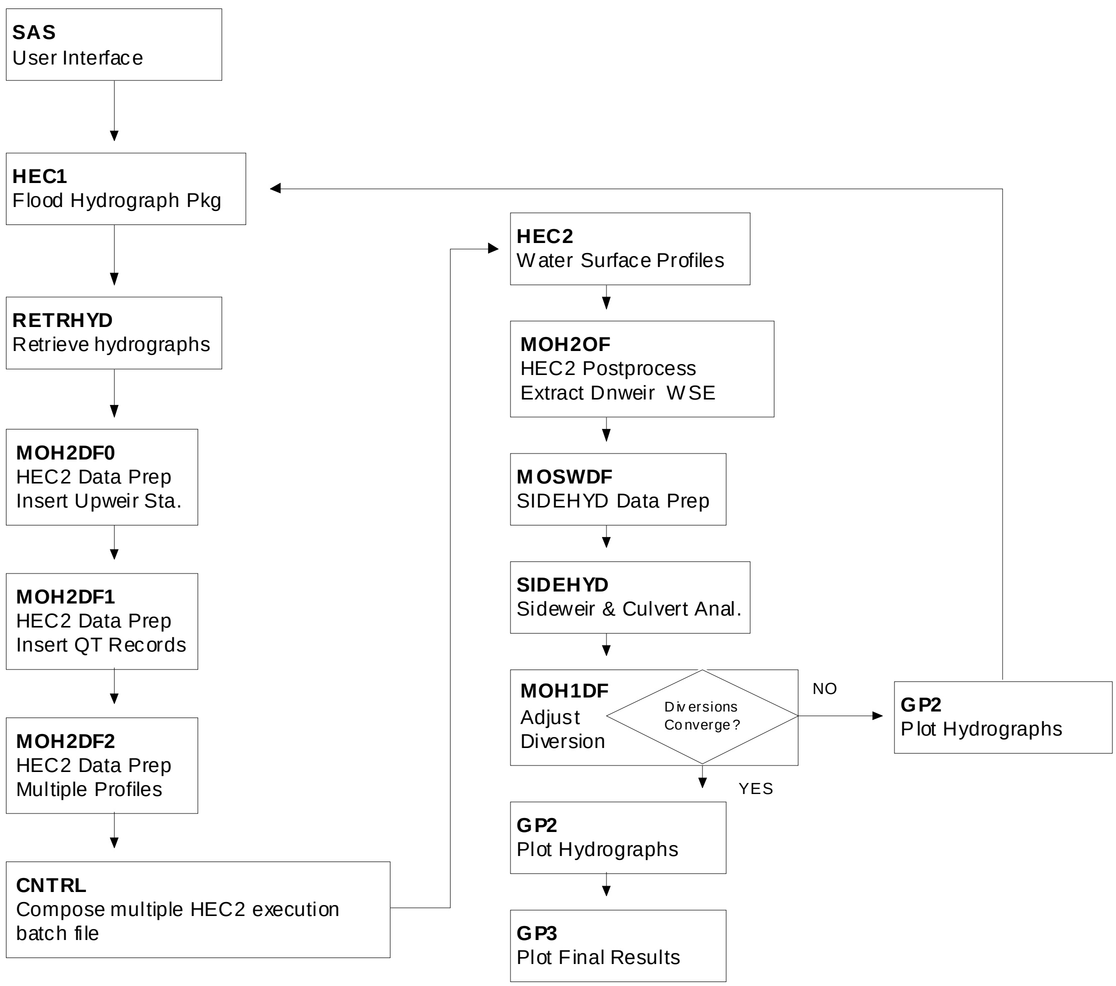


Fig. 4.1 - Flow chart for SAS for one diversion

Table 4.1 - Side-Diversion Analysis System for One Diversion

SCRIPT	PROGRAM	INPUT	OUTPUT
GO.BAT	SAS.EXE	interactive user	CNTRL.DAT, SCRIPT1.BAT
SCRIPT1.BAT (first iteration), SCRIPT3.BAT (subsequent iterations)	HEC1.EXE	[HEC1.DAT]* (first iteration), MOH1DF.OUT (subsequent iterations)	HEC1.OUT
	RETRHYD.EXE	HEC1.OUT	RETRHYD.OUT
	MOH2DF0.EXE**	[HEC2.DAT]*, [SIDEHYD.DAT]*, CNTRL.DAT	MOH2DF0.OUT
	MOH2DF1.EXE	CNTRL.DAT, MOH2DF0.OUT, RETRHYD.OUT, RERNTOL.DAT, SIDEHYD.PLT (except on first iteration)	MOH2DF1.OUT, CNTRL.DAT
	MOH2DF2.EXE	CNTRL.DAT, MOH2DF1.OUT	MOH2DF2.D01 - Dn, CNTRL.DAT
	CNTRL.EXE	CNTRL.DAT	SCRIPT2.BAT
SCRIPT2.BAT	HEC2.EXE	MOH2DF2.D01 - Dn	D01 - Dn
	MOH2OF.EXE	CNTRL.DAT, D01 - Dn	MOH2OF.OUT
	MOSWDF.EXE	[SIDEHYD.DAT]*, CNTRL.DAT, MOH2OF.OUT, RERNTOL.DAT	MOSWDF.OUT
	SIDEHYD.EXE	MOSWDF.OUT	SIDEHYD.OUT, SIDEHYD.PLT
	MOH1DF.EXE	[HEC1.DAT]*, CNTRL.DAT, RERNTOL.DAT, RETRHYD.OUT, SIDEHYD.OUT	SIDEHYD.HST, MOH1DF.OUT, SCRIPT3.BAT
	GP2.EXE	SIDEHYD.PLT, CNTRL.DAT, RETRHYD.OUT, SIDEHYD.HST	screen graphic, printer plot
SCRIPT3.BAT (final iteration)	GP3.EXE	CNTRL.DAT, SIDEHYD.PLT	screen graphic, printer plot

*[ ] indicates user-supplied file
**MOH2DF0.EXE does not run during the first iteration.

4.1.2 - Two Diversions

Most of the system for two diversions (Fig. 4.2, Table 4.2) is similar to that for one diversion. The user begins by typing GO at the DOS prompt, initiating the batch file GO.BAT, which in turn executes the program SAS.EXE that produces the User Interface. The input filenames, station numbers and Hydrograph Threshold discharge are entered into the User Interface, which creates the CNTRL1.DAT, CNTRL2.DAT and the SCRIPT1.BAT files. Control transfers to SCRIPT1. BAT, which executes HEC-1 and then RETRHYD.EXE. Three preprocessors (MOH2DFK. EXE, MOH2DF1.EXE, and MOH2DF2.EXE) assemble the HEC-2 input files and then KCNTRL.EXE produces the next batch file, SCRIPT2.BAT. Control transfers to SCRIPT2. BAT and HEC-2 is executed the required number of times. The underlined programs in the part of Table 4.2 inside the heavy outline are executed twice, once for each weir. The general filenames are shown in Table 4.2, but many of the three character extensions on the filenames end in 1 for the upstream diversion and 2 for the downstream diversion on the second execution rather than the last letter shown in the table. The calculations are done first for the upstream diversion. The output files from HEC-2 (D01 - Dn) are post-processed by MOH2OF.EXE to produce MOH2OF.OU1, which is combined with the upstream SIDEHYD base data file to produce MOSWDF.OUT for the upstream diversion. This is an input file for the first SIDEHYD.EXE run, producing SIDEHYD.OU1 and SIDEHYD.PL1. MOH1DF.EXE is executed to produce MOH1DF.OU1. The output files from HEC-2 are post-processed again by MOH2OF.EXE, this time for the ATWEIR station for the downstream diversion, to produce MOH2OF.OU2. MOSWDF.EXE combines this information with the information included in the downstream SIDEHYD base data file producing MOSWDF.OUT, the required input file for the second execution of SIDEHYD.EXE. SIDEHYD produces SIDEHYD.OU2 and SIDEHYD. PL2. MOH1DF.EXE is executed a second time to produce MOH1DF.OU2. Finally the program MO2H1DF.EXE runs combining the MOH1DF.OU1 and MOH1DF.OU2 data files into a single HEC-1 input data file named MOH1DF.OUT. This final program also checks the stopping criteria and writes the SCRIPT3.BAT accordingly. Then GP2.EXE produces the on-screen plots. If the stopping criteria are not met, HEC1.EXE is re-executed using MOH1DF.OUT for input and the entire process reiterates. If the stopping criteria are met, the graphics program GP3.EXE is executed to display the final results and SAS exits to DOS.

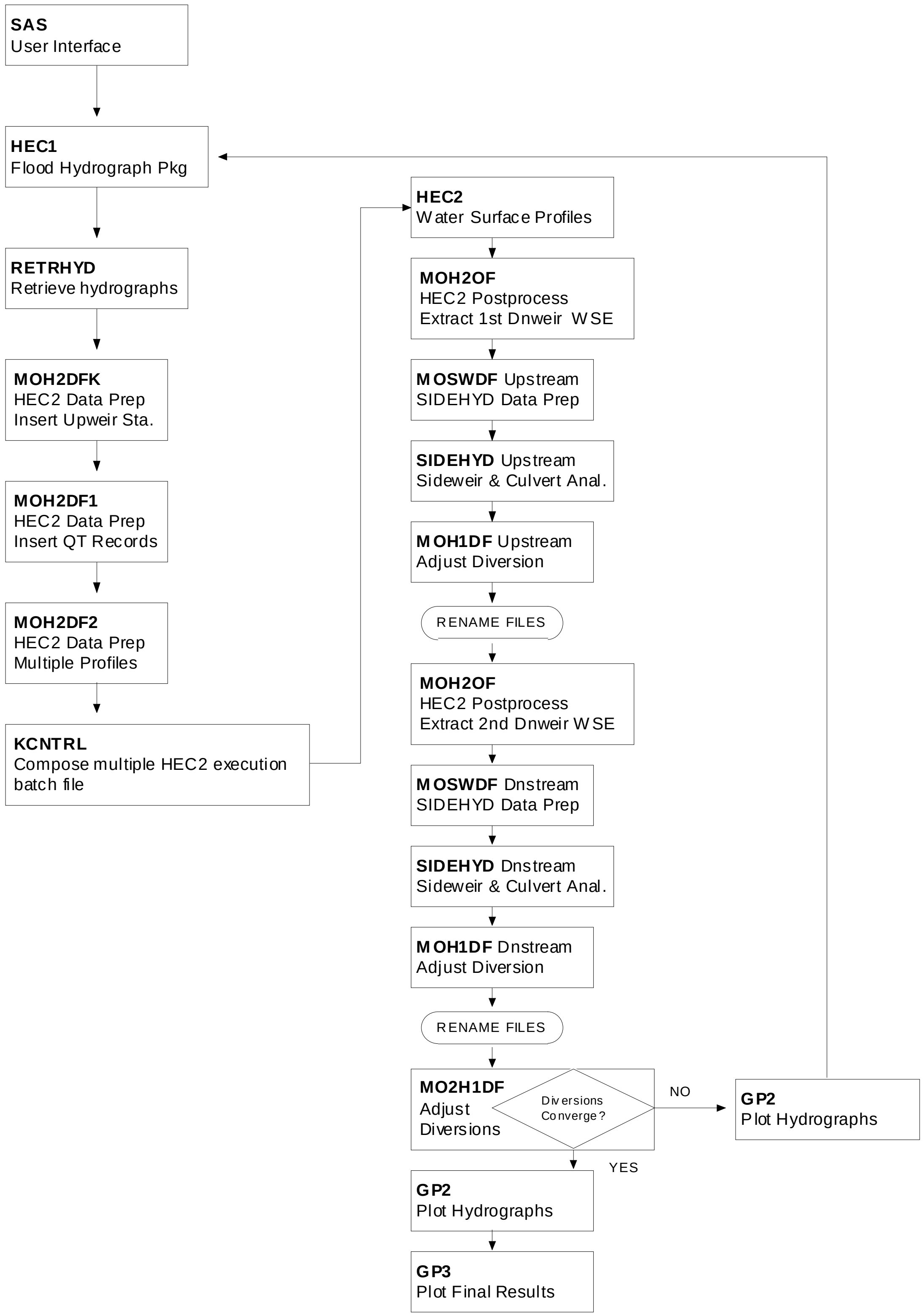


Fig. 4.2 - Flow chart for SAS for two diversions

Table 4.2 - Side-Diversion Analysis System for Two Diversions

SCRIPT	PROGRAM	INPUT	OUTPUT
GO.BAT	SAS.EXE	interactive user	CNTRL1.DAT, CNTRL2.DAT, SCRIPT1.BAT
SCRIPT1.BAT (first iteration), SCRIPT3.BAT (subsequent iterations)	HEC1.EXE	[HEC1.DAT]* (first iteration), MOH1DF.OUT (subsequent iterations)	HEC1.OUT
	RETRHYD.EXE	HEC1.OUT	RETRHYD.OUT
	MOH2DFK.EXE**	[HEC2.DAT]*, both [SIDEHYD. DAT]* files, CNTRL1.DAT, CNTRL2.DAT	MOH2DF0.OUT
	MOH2DF1.EXE	CNTRL1.DAT, MOH2DF0.OUT, RETRHYD.OUT, RERNTOL.DAT, SIDEHYD.PL1 and SIDEHYD.PL2 (except on first iteration)	MOH2DF1.OUT, CNTRL1.DAT
	MOH2DF2.EXE	CNTRL1.DAT, MOH2DF1.OUT	MOH2DF2.D01 - Dn, CNTRL1.DAT
	KCNTRL.EXE	CNTRL1.DAT, CNTRL2.DAT	SCRIPT2.BAT
SCRIPT2.BAT	HEC2.EXE	MOH2DF2.D01 - Dn	D01 - Dn
	<u>MOH2OF.EXE</u>	CNTRL.DAT, D01 - Dn	MOH2OF.OUT
	<u>MOSWDF.EXE</u>	[SIDEHYD.DAT]*, CNTRL.DAT, MOH2OF.OUT, RERNTOL.DAT	MOSWDF.OUT
	<u>SIDEHYD.EXE</u>	MOSWDF.OUT	SIDEHYD.OUT, SIDEHYD.PLT
	<u>MOH1DF.EXE</u>	[HEC1.DAT]*, CNTRL.DAT, RERNTOL.DAT, SIDEHYD.OUT	SIDEHYD.HST, MOH1DF.OUT, SCRIPT3.BAT

*[ ] indicates user-supplied file
**MOH2DFK.EXE does not run during the first iteration.

Table 4.2 - Side-Diversion Analysis System for Two Weirs (continued)

SCRIPT	PROGRAM	INPUT	OUTPUT
SCRIPT2.BAT (continued)	MO2H1DF.EXE	CNTRL2.DAT, MOH1DF.OU1, MOH1DF.OU2, RERNTOL.DAT, SIDEHYD.HS1, SIDEHYD.HS2	MOH1DF.OUT, SCRIPT3.BAT
	GP2.EXE	CNTRL.DAT, RETRHYD.OUT, SIDEHYD.PLT, SIDEHYD.HST	screen graphic, printer plot
SCRIPT3.BAT (final iteration)	GP3.EXE	CNTRL.DAT, SIDEHYD.PLT	screen graphic, printer plot

4.1.3 - Batch Files

Batch files are used in this system to control the sequence of file manipulations and data processor executions. These DOS command sequences are not static from one analysis to the next or even from one iteration to the next. For this reason, batch files appropriate to each series of steps are composed just before they are required. Command control is passed to the new batch file by the final command of the current batch file. This process can be seen in examples that follow.

4.1.3.1 - GO.BAT

This batch file resides in the directory C:\SAS and is invoked when the user types “GO” at the DOS Prompt to invoke GO.BAT, which is shown below. GO.BAT deletes any remaining files from previous runs and then executes the User Interface. When that interactive process is completed, control is transferred to SCRIPT1.BAT.

```
@DEL *.OU?
@DEL MOH2DF2.D*
@DEL H2CON.D*
@DEL *.PL?
@DEL *.HS?
@DEL D??
@DEL TAPE*.*
@DEL ZZ*.*
@DEL SCRIPT?.BAT
C:\H1H2SH\SAS.EXE
SCRIPT1.BAT
```

4.1.3.2 - SCRIPT1.BAT

When GO.BAT is invoked, the SCRIPT1.BAT file does not yet exist. SAS.EXE creates SCRIPT1.BAT and CNTRL.DAT using information provided by the user. The name of the HEC-1 input file changes from one run to the next depending on information supplied by the user. Notice that the HEC-1 executable is called by filename only. This convention assumes that the PATH feature of DOS is set up to include the directory of the HEC-1 executable. An example SCRIPT1.BAT file for a one-diversion analysis is listed below.

```
HEC1.EXE INPUT=C:\SAS\A1.H1D OUTPUT=HEC1.OUT
@DEL TAPE23
@DEL TAPE24
@DEL TAPE25
C:\H1H2SH\RETRHYD.EXE
COPY C:\SAS\A1.H2D MOH2DF0.OUT
C:\H1H2SH\MOH2DF1.EXE
C:\H1H2SH\MOH2DF2.EXE
C:\H1H2SH\CNTRL.EXE
SCRIPT2.BAT
```

An example SCRIPT1.BAT file for a two-diversion analysis is as follows.

```
HEC1.EXE INPUT=C:\SAS\B1.H1D OUTPUT=HEC1.OUT
@DEL TAPE23
@DEL TAPE24
@DEL TAPE25
@COPY CNTRL1.DAT CNTRL.DAT
C:\H1H2SH\RETRHYD.EXE
COPY C:\SAS\A1.H2D MOH2DF0.OUT
C:\H1H2SH\MOH2DF1.EXE
C:\H1H2SH\MOH2DF2.EXE
@COPY CNTRL.DAT CNTRL1.DAT
@DEL CNTRL.DAT
C:\H1H2SH\KCNTRL.EXE
SCRIPT2.BAT
```

4.1.3.3 - SCRIPT0.BAT

SCRIPT0.BAT is a utility batch file that is created when a user selects “EXIT” from the initial SAS User Interface. There are two important control aspects to this file:

(1) The script itself is not executed automatically.

(2) The final command is not another batch control command. Thus, execution halts after the batch file sequence is completed.

The structure and contents of the SCRIPT0.BAT file are identical to the script file that would have been created by selecting “CALC” from the SAS Input Form except that the final command, “SCRIPT2.BAT”, is omitted. A user who wishes to step manually through the iterations can therefore fill in the blanks on the User Interface and select “EXIT” rather than “CALC”. That action returns control to the DOS Prompt where the user would enter the command “SCRIPT0.BAT” to begin the process. The first steps in the procedure would be executed including the steps creating the next batch file in the sequence, SCRIPT2.BAT, whereupon control would then return to DOS. The user could at that time inspect intermediate files, inspect and edit the SCRIPT2.BAT file, or continue the procedure by typing SCRIPT2.BAT at the DOS Prompt. An example SCRIPT0.BAT file is presented below for the two-weir example.

```
HEC1.EXE INPUT=C:\SAS\B1.H1D OUTPUT=HEC1.OUT
@DEL TAPE23
@DEL TAPE24
@DEL TAPE25
@COPY CNTRL1.DAT CNTRL.DAT
C:\H1H2SH\RETRHYD.EXE
COPY C:\SAS\A1.H2D MOH2DF0.OUT
C:\H1H2SH\MOH2DF1.EXE
C:\H1H2SH\MOH2DF2.EXE
@COPY CNTRL.DAT CNTRL1.DAT
@DEL CNTRL.DAT
C:\H1H2SH\KCNTRL.EXE
```

4.1.3.4 - SCRIPT2.BAT

The SCRIPT2.BAT file is created by the FORTRAN executable program CNTRL.EXE. The initial lines of the batch file call for executions of HEC-2. As before, the reference assumes that the directory containing this executable is provided in the PATH. Both the number of times that HEC-2 is executed and the filenames of the input and output depend on the number of multiple profile runs needed to model the duration of flow above the user-specified Hydrograph Threshold discharge. Subsequent lines in the file execute a post-processing program to collect pertinent output from the HEC-2 output files and a pre-processing program to incorporate that information into a SIDEHYD input file. SIDEHYD is executed, a graphic is shown on the screen, and the program MOH1DF.EXE is executed to check stopping criteria, modify the HEC-1 input file appropriately, and produce the next script file, SCRIPT3.BAT. Listed below is an example SCRIPT2.BAT file for a one-diversion analysis.

```
HEC2 INPUT=MOH2DF2.D01 OUTPUT=D01 TAPE95=TAPE95 >H2CON.D01
@DEL TAPE*.*
HEC2 INPUT=MOH2DF2.D02 OUTPUT=D02 TAPE95=TAPE95 >H2CON.D02
@DEL TAPE*.*
HEC2 INPUT=MOH2DF2.D03 OUTPUT=D03 TAPE95=TAPE95 >H2CON.D03
@DEL TAPE*.*
```

```
C:\H1H2SH\MOH2OF.EXE
C:\H1H2SH\MOSWDF.EXE
C:\H1H2SH\SIDEHYD.EXE INPUT=MOSWDF.OUT
C:\H1H2SH\MOH1DF.EXE
C:\H1H2SH\GP2.EXE
SCRIPT3.BAT
```

Listed below is an example SCRIPT2.BAT file for a two-diversion analysis.

```
HEC2 INPUT=MOH2DF2.D01 OUTPUT=D01 TAPE95=TAPE95 >H2CON.D01
@DEL TAPE*.*
HEC2 INPUT=MOH2DF2.D02 OUTPUT=D02 TAPE95=TAPE95 >H2CON.D02
@DEL TAPE*.*
HEC2 INPUT=MOH2DF2.D03 OUTPUT=D03 TAPE95=TAPE95 >H2CON.D03
@DEL TAPE*.*
@COPY CNTRL1.DAT CNTRL.DAT
C:\H1H2SH\MOH2OF.EXE
C:\H1H2SH\MOSWDF.EXE
C:\H1H2SH\SIDEHYD.EXE INPUT=MOSWDF.OUT
C:\H1H2SH\MOH1DF.EXE
@COPY CNTRL.DAT CNTRL1.DAT
@COPY MOH1DF.OUT MOH1DF.OU1
@DEL MOH1DF.OUT
@COPY SIDEHYD.OUT SIDEHYD.OU1
@DEL SIDEHYD.OUT
@COPY SIDEHYD.PLT SIDEHYD.PL1
@DEL SIDEHYD.PLT
@COPY SIDEHYD.HST SIDEHYD.HS1
@DEL SIDEHYD.HST
@COPY CNTRL2.DAT CNTRL.DAT
C:\H1H2SH\MOH2OF.EXE
C:\H1H2SH\MOSWDF.EXE
C:\H1H2SH\SIDEHYD.EXE INPUT=MOSWDF.OUT
C:\H1H2SH\MOH1DF.EXE
@COPY CNTRL.DAT CNTRL2.DAT
@COPY MOH1DF.OUT MOH1DF.OU2
@DEL MOH1DF.OUT
@COPY SIDEHYD.OUT SIDEHYD.OU2
@DEL SIDEHYD.OUT
@COPY SIDEHYD.PLT SIDEHYD.PL2
@DEL SIDEHYD.PLT
@COPY SIDEHYD.HST SIDEHYD.HS2
@DEL SIDEHYD.HST
C:\H1H2SH\MO2H1DF.EXE
@COPY CNTRL1.DAT CNTRL.DAT
C:\H1H2SH\GP2.EXE
SCRIPT3.BAT
```

4.1.3.5 - SCRIPT3.BAT

The SCRIPT3.BAT file is created by the FORTRAN executable program MOH1DF. EXE. This program can take two general forms depending on whether the stopping criteria have been met. The first example illustrates a one-diversion analysis with stopping criteria not met:

```
HEC1.EXE INPUT=MOH1DF.OUT OUTPUT=HEC1.OUT
@DEL TAPE23
@DEL TAPE24
@DEL TAPE25
C:\H1H2SH\RETRHYD.EXE
C:\H1H2SH\MOH2DF0.EXE
C:\H1H2SH\MOH2DF1.EXE
C:\H1H2SH\MOH2DF2.EXE
C:\H1H2SH\CNTRL.EXE
SCRIPT2.BAT
```

The next example illustrates a one-diversion analysis with stopping criteria met:

```
C:\HlH2SH\GP3.EXE
@TYPE MESSAGE.TXT
```

The following example illustrates a two-diversion analysis with stopping criteria not met:

```
HEC1.EXE INPUT=MOH1DF.OUT OUTPUT=HEC1.OUT
@DEL TAPE23
@DEL TAPE24
@DEL TAPE25
C:\HlH2SH\RETRHYD.EXE
COPY CNTRL1.DAT CNTRL.DAT
C:\HlH2SH\MOH2DFK.EXE
C:\HlH2SH\MOH2DFl.EXE
C:\HlH2SH\MOH2DF2.EXE
COPY CNTRL.DAT CNTRL1.DAT
C:\HlH2SH\KCNTRL.EXE
SCRIPT2.BAT
```

The final example illustrates a two-diversion analysis with stopping criteria met:

```
C:\H1H2SH\GP3.EXE
@TYPE MESSAGE.TXT
```

4.1.3.6 - MESSAGE.TXT

At the end of the calculations, the following file is written to the screen to remind the user to review the output files:

```
Review HEC-1, HEC-2, and SIDEHYD output files for warnings and
messages.  The filenames are as follows:

PROGRAM | ONE WEIR/CULV  | TWO WEIRS/CULVERTS
========|================|=======================================
HEC-1   | HEC1.OUT       | HEC1.OUT
HEC-2   | D01 - Dn       | D01 - Dn
SIDEHYD | SIDEHYD.OUT    | SIDEHYD.OU1 for upstream weir/culvert
                         | SIDEHYD.OU2 for downstream weir/culvert

The files are in the C:\SAS directory.
```

Blank lines are the beginning and end of this file are not included here.

4.1.4 - RERNTOL.DAT FILE

RERNTOL.DAT is a data file that contains four execution control parameters for the Side-Diversion Analysis System. For most problems, these parameters need not be adjusted. A sample file is listed below:

```
MERNTOL=     0.075      Fixed field, right justified in column 18, floating point
INCHORD=         2      Fixed field, right justified in column 18, integer
WEIGHT =      0.25      Fixed field, right justified in column 18, floating point
HOLD   =        10      Fixed field, right justified in column 18, integer
```

The first parameter (MERNTOL) gives the convergence criterion for the major execution loop in SAS. As currently set, when the largest normalized difference between the assumed and computed weir discharges is less than 0.075 (i.e., 7.5%), the program will produce final solution graphs to the screen and stop. Values between 0 and 1 are valid. Higher values of this parameter within the range of 0 to 1 reduce the number of iterations required but also decrease the accuracy of the final solution. The value 0.075 is recommended if the same value is to be used for both one-diversion and two-diversion cases. One-weir cases normally converged 10 to 15 iterations with MERNTOL = 0.05. The one-weir example in Section 3.6.1 converged in 13 iterations with MERNTOL = 0.05 (Fig. 4.3). The two-weir example in Section 3.6.2 converged in 29 iterations with MERNTOL = 0.05 (Fig. 4.4).

The second parameter (INCHORD) controls the number of the discharges calculated by HEC-1 that are used in the subsequent HEC-2 analysis. A value of 1 would use every discharge calculated by HEC-1. A value of 2 uses alternate values, and so on. Integer values ≥ 1 are valid. Resolution of the continuous variation in flow and stage decreases with higher values of this parameter as does also the number of executions of HEC-2 and consequently the time of execution required for each iteration of the major loop.

As mentioned in Section 2.1.1, the calculation process in SAS is iterative starting with an assumed diversion hydrograph and then calculating a new diversion hydrograph. The next iteration starts with an assumed hydrograph that is an average of the previously assumed and previously calculated hydrographs. The third parameter is a weighting factor that controls this averaging. A value of 0.25 means that the new assumed diversion hydrograph is 0.25 times the last calculated hydrograph plus 0.75 times the previously assumed hydrograph. The valid range for this parameter is from 0 to 0.5. Higher values within this range increase the speed of convergence. Lower values increase the solution stability and the calculation time.

The influence of the WEIGHT parameter is illustrated in Fig. 4.3 for a one-weir problem. For this case, WEIGHT = 0.50 causes MERN to initially decrease more rapidly than WEIGHT = 0.25, so that convergence is achieved with a tolerance of 0.075 in 6 iterations with WEIGHT = 0.5 whereas 11 iterations are required with WEIGHT = 0.25. If the tolerance is 0.05, the two value of WEIGHT give convergence in the same number of iterations (13) because WEIGHT = 0.5 causes large oscillations in the values of MERN after MERN first drops below 0.075.

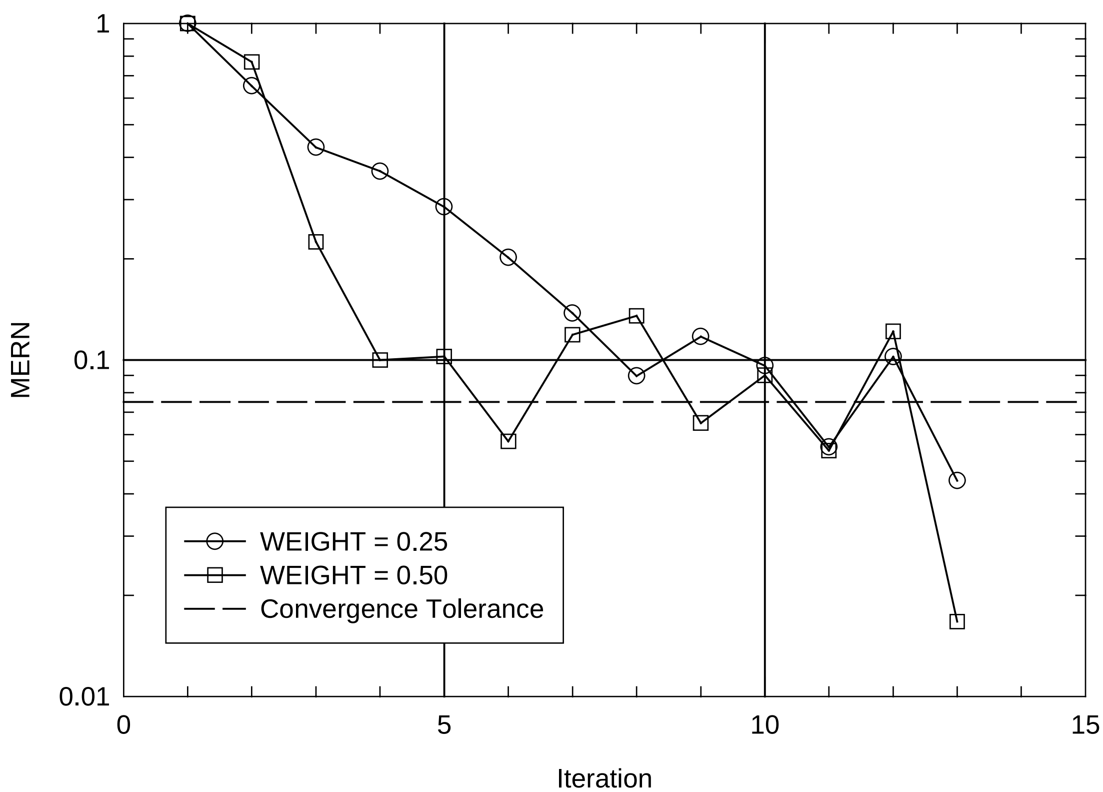


Fig. 4.3 - Effect of WEIGHT on one-weir calculation

Fig. 4.4 gives similar results for a two-weir problem. In this case, WEIGHT = 0.25 gives faster initial and ultimate decreases in MERN because the oscillations at one weir caused by using WEIGHT = 0.5 propagate along the stream and create oscillations at the other weir. For this case, the oscillations caused by using WEIGHT = 0.5 are clearly larger at both weirs than those when WEIGHT = 0.25. Thus, smaller values of WEIGHT give a damping effect on the calculations. For this reason, WEIGHT = 0.25 is used for the calculations. The additional time required for the one-weir calculations is not very large when 0.25 is used rather than 0.50. The two-weir calculations are faster with WEIGHT = 0.25. One test case with two weirs and WEIGHT = 0.50 did not converge after 100 iterations.

It should also be noticed that MERN does not have a smooth decrease during the iterations. Thus, there is no cause for concern if this value is seen to oscillate during the iterations. The results of the calculations for both Fig. 4.3 and Fig. 4.4 are shown after the convergence tolerance has been met to illustrate that the oscillations in the values of MERN continue throughout the calculations.

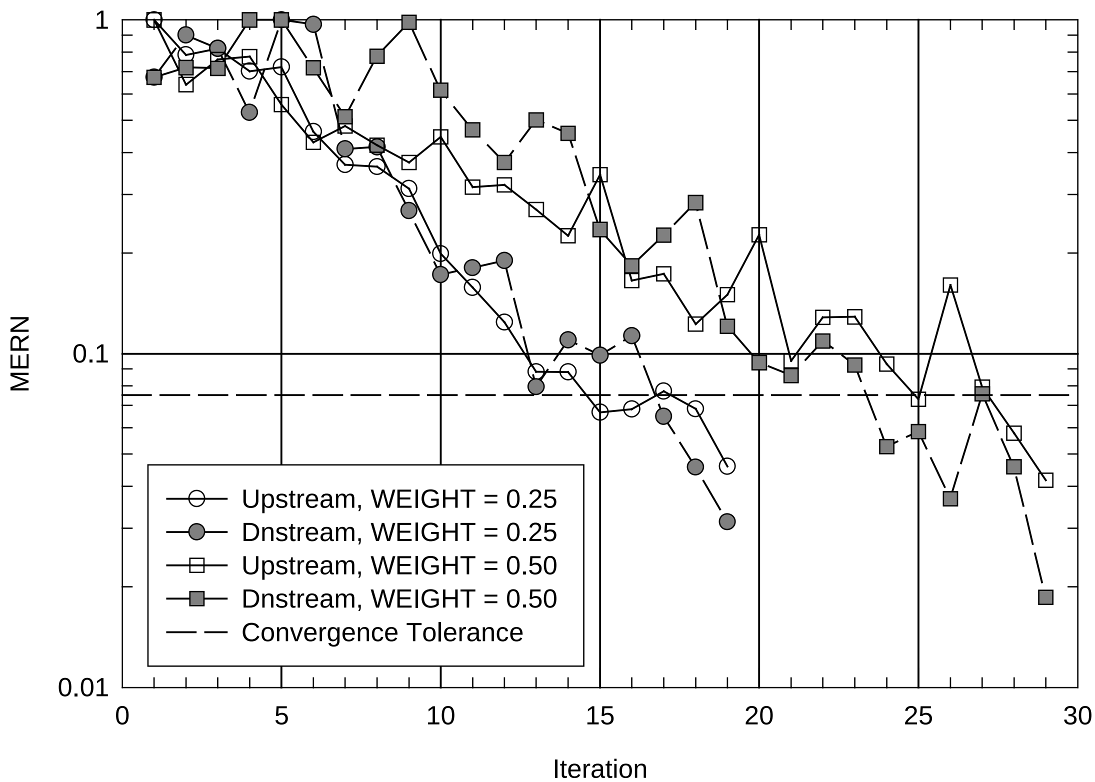


Fig. 4.4 - Effect of WEIGHT on two-weir calculation

HOLD is the time in seconds that the graphs produced by GP2.EXE remain on the screen. See Section 3.5.1. If HOLD is set to zero in the input file, SAS will run in the background when run in a DOS window under the Windows operating system; that is the graphs showing the results at the end of each iteration are not shown on the monitor.

4.2 - FUNCTIONAL DESCRIPTION OF PROGRAMS

This section gives a summary of the various programs used in the Side-Diversion Analysis System.

4.2.1 - SAS.FRM

SAS.EXE is the Visual Basic User Interface for the Side-Diversion Analysis System. The source file is SAS.FRM. The purpose of this program is to acquire base input data filenames, UPWEIR, ATWEIR and DNWEIR station numbers, and hydrograph threshold discharge.

Major steps:

Check for existing CNTRL.DAT file.
If CNTRL.DAT file present, read file and fill default values into text boxes.
Respond to point-and-click or select-and-enter to accept new information into text boxes.
On CALC: Collect the data in the text boxes.
Create a new CNTRL.DAT file.
Create the SCRIPT1.BAT file.
Close the files and end
On EXIT: Create the SCRIPT0.BAT file.
Close the files and end

4.2.2 - HEC1.FOR

HEC1.FOR is a Fortran program from the Hydrologic Engineering Center of the U. S. Army Corps of Engineers. It simulates surface runoff from a watershed due to precipitation and does hydrologic modeling of channel routing. The program gives discharge hydrographs at desired locations. It is assumed that the users of SAS are already familiar with HEC-1, so the program and its input and output are not described here. In March 2002, complete information could be obtained from

Hydrologic Engineering Center
U. S. Army Corps of Engineers
609 Second Street
Davis, CA 95616-4687
(916) 756-1104
http://www.hec.usace.army.mil/software/index.html

An example input file, A1.H1D, is included in Appendix 6.2.1. The excerpt below illustrates how weir diversion must be specified in the base data file. The DNWEIR station is 85042. The ATWEIR Station is 85167. This example diverts all flow above 12000 cfs away from the main channel. This situation represents a first estimate of the performance of the weir diversion.

```
KK 85042DIVERT FLOW TO POND 25
DT 85167
DI     0    5000   12000   18000   25000
DQ     0       0       0    6000   13000
KO     2
```

Subsequent iterations of the Side-Diversion Analysis System gradually refine this estimate of the diversion and automatically revise these input records until a hydrologically and hydraulically consistent solution is found.

For diversion culverts, the format of the estimate of the initial diversion is the same as for weirs. However, the width of the culverts is less than the length of the weir crest and the diversion capacity is smaller. Thus, some of the numbers change, as illustrated below.

```
KK 85042DIVERT FLOW TO POND 25
DT 85066
DI     0    5000   12000   20000   25000
DQ     0       0       0       0    3000
KO     2
```

4.2.3 - RETRHYD.FOR

RETRHYD.FOR is a Fortran program for retrieving and manipulating hydrographs from the HEC-1 output files.

Major steps:

100	Read the HEC-1 output file searching for hydrograph table. On end of file go to 500.
200	Read the time and flow data from the 8x75 HEC-1 table.
300	Write the time and flow data to 2x300 format.
400	Return to 100.
500	Close files and end.

4.2.4 - MOH2DF0.FOR

MOH2DF0.FOR is a Fortran program to insert a cross section in the HEC-2 data file at the UPWEIR station for problems with one weir.

Major steps:

	Read CNTRL.DAT. Get the name of the HEC-2 base data file. Read the station numbers UPWEIR, ATWEIR, AND DNWEIR. Open the HEC-2 base data file. Open the output file for this program.
200	Read lines in the HEC-2 base data file. Process X1 records at 300 below.

	Process all other records at 500 below.
300	Read the station number from the base data file.
	If it is greater than the DNWEIR station, process at 600 otherwise...
500	Write the record to output.
	Return to 200.
600	Open the SIDEHYD base data file to get the weir length or culvert width. Recalculate reach lengths.
	Write the modified X1 record that follows the UPWEIR station.
900	Close files and exit.

4.2.5 - MOH2DFK.FOR

MOH2DFK.FOR for two weirs is similar to MOH2DF0.FOR for one weir. It inserts a cross section in the HEC-2 data file at the UPWEIR station for both diversion structures.

4.2.6 - MOH2DF1.FOR

MOH2DF1.FOR is a Fortran program for finding ITIME and JTIME for beginning and end, respectively, of flow above threshold at the UPWEIR station (for the upstream diversion structure, if there are two diversions), for making J3 and QT modifications to HEC-2 input data, and for adding time information to the CNTRL.DAT file.

Major steps:

	Read the control file.
	Get the Hydrograph Threshold discharge.
	Get the HEC-1 ITIME.
	Get the UPWEIR station number.
	Open the MOH2DF0.OUT file and the RETRHYD.OUT, which contains the list of HEC-1 hydrographs.
	Open the output file for this program. (MOH2DF1.OUT)
120	Search for the UPWEIR station number.
	When found go to 150.
	When not found, skip 300 lines of hydrograph discharges.
	Go back to 120 and try again.
150	Print to screen the success in finding the UPWEIR station.
	Read the data pertaining to the UPWEIR station.
	Find the first time the flow is greater than the threshold.
	Find the last time the flow is greater than the threshold.
	Rewind the list of hydrographs.
200	Read lines in the HEC-2 base data file.
	Ignore all QT records in the base data file.
	Process J3 records at 250.
	Process X1 records at 300.
	Process all other records at 500.
250	Rewrite the J3 record to produce summaries in HEC-2 output.
300	Rewind the list of hydrographs.

Read the station number from the base data file.
Compose and write an X5 record.
Read the station number in the list of hydrographs.
If the stations numbers agree, process at 400.
Otherwise, skip 300 lines of hydrograph discharges and try again.
Process at 500 since this station is not in the hydrograph list

400 Retrieve hydrograph from the list.
Display QT station message to screen.
Compose a new set of QT records and write them to output.
Process the X1 record itself at 500.

500 Write the record to output.
Return to 200.
At end of input file, close all files.
Rewrite control file with new time, date, ITIME and JTIME.
Close control file and end.

4.2.7 - MOH2DF2.FOR

MOH2DF2.FOR is a third Fortran program for manipulation of the HEC-2 input files.

Major steps:

Read the control file.
Add 1 to the iteration count.
Open the intermediate input file MOH2DF1.OUT.

100 Read the title and job records.
Find the first QT record and go to 200.

200 Count number of QT records that occur in sequence.
Go through the main loop that many times.
Create a new output file and name it appropriately.
Rewind the input file.

310 Read a line from input.
If it is a QT or an X5 record, go to 400 to process it.
If it is an EJ record, go to 500 to process it.
Otherwise copy it and go to 310.

400 Skip if necessary to the appropriate QT or X5 record
Read the number of flows field.
Write the line to output.
If this is not the last QT record, skip the rest.
Go to 310 and read the next line.

500 Set up the multiple profile job control stack.
Close the output file.
Close the input file.
Write the CNTRL.DAT file.
Close the control file and end.

4.2.8 - CNTRL.FOR

CNTRL.FOR is a Fortran control program to create the SCRIPT2.BAT file.

Major steps:

Open and read the CNTRL.DAT file.
Get the number of HEC2.Dn files.
Open and write variable part of the SCRIPT2.BAT file.
Write the static part of the SCRIPT2.BAT file.
Close the files and end.

4.2.9 - KCNTRL.FOR

KCNTRL.FOR is a Fortran control program to create the SCRIPT2.BAT file for a two-diversion analysis.

Major steps:

Open and read the CNTRL1.DAT file.
Open and read the CNTRL2.DAT file
Get the number of HEC2.D0n files.
Open and write variable part of the SCRIPT2.BAT file.
Write the static part of the SCRIPT2.BAT file.
Close the files and end.

4.2.10 - HEC2.FOR

HEC2.FOR is a Fortran program from the Hydrologic Engineering Center of the U. S. Army Corps of Engineers. HEC-2 calculates water surface profiles for steady gradually varied flow in natural or man-made channels. The program uses the Standard Step Method to solve the one-dimensional energy equation with energy loss due to friction evaluated by Manning's equation (or other resistance relationships) and with additional losses for channel expansions and contractions. It is assumed that the users of SAS are already familiar with HEC-2, so the program and its input and output are not described here. In March 2002, complete information could be obtained from

Hydrologic Engineering Center
U. S. Army Corps of Engineers
609 Second Street
Davis, CA 95616-4687
(916) 756-1104
http://www.hec.usace.army.mil/software/index.html

An example input data file, A1.H2D, appears in Appendix 6.2.5. The records below are excerpts from that appendix and illustrate how the DNWEIR station (85042) appears.

```
QT     1   13400
Xl 85042      18   20300   20469    1300     800    1109
CI    -1   66.78   0.035     2.5     2.5     -45     -45
GR   100   18000      95   19050    90.7   20000    90.8   20100    90.9   20200
GR  89.5   20300    77.6   20327    75.1   20330    74.4   20337    74.8   20345
GR  77.6   20347      81   20430    94.7   20469    93.5   20500    93.3   20600
GR  93.7   20700      94   22600      95   22610
```

4.2.11 - MOH2OF.FOR

MOH2OF.FOR is a Fortran program for extracting HEC-2 output for the downstream end of the diversion structure, or structures for the two-diversion case.

Major steps:

	Open and read the CNTRL.DAT file.
	Read the number of Dn files.
	Read the DNWEIR station number.
	Open the output file.
	Loop for as many times as there are HEC-2 output Dn files (where n is I2.2 format).
	Open the next HEC-2 output file as input.
120	Read a record. If end of file, go to 190.
	Read the station number; on any error go to 120.
	If the line refers to the DNWEIR station, write it to output.
	Go to 120 and try again.
190	Close the current HEC-2 output file.
200	End of loop.
	Close the output file.
900	Close the files and exit.

4.2.12 - MOSWDF.FOR

MOSWDF.FOR is a Fortran program for modifying the SIDEHYD input file using HEC-2 flow.

Major steps:

Read the CNTRL.DAT file.
Get the name of the SIDEHYD base data file.
Get the time step and start time of the HEC-1 flow.
Get the time for flow above threshold.
Open the SIDEHYD base data file and the output files.
Read the first line from the base data file.

Compose a new first line and write it to output.
Read and write the title records.
Read and write the next four lines of the base data file to output.
Read and write the basin geometry data.
Open the HEC-2 output summary and count the number of lines.
Rewind the HEC-2 output summary.
Write the HEC-2 output summary to output.
Compute the zero time for flow above threshold.
Loop to add the HEC-2-generated hydrograph to MOSWDF.OUT.
Compute the time associated with the event.
Close the MOH2OF.OUT file.
Skip the hydrograph ordinates provided in the base data file.
Read and write the drainage culvert information (if any).
Close the base data file and output files and end.

4.2.13 - SIDEHYD.FOR

SIDEHYD.FOR is a Fortran program for calculating diversion hydraulics and for tracking the filling and emptying of the detention basin. It also models the channel flow beside a side diversion structure. This program is a modified version of the program previously called SIDEHYDR and reported in Davis and Holley (1988). Major improvements to the program include:

(1) Capability to model detention basin drainage culverts.
(2) Automatic decrease of the computational time step to aid convergence.
(3) Increased dimensions for time-subscripted variables.
(4) Automatic increase of the computational time step during culvert drainage.
(5) Expanded warning and error messages for troubleshooting.
(6) Optional weir or culvert diversion.
(7) An improved method to calculate forward flow over the weir to account for different channel slopes, roughnesses, and side slopes.

THYSYS (TxDOT, 1977) and its subroutines are subroutines of SIDEHYD. Only a small part of THYSYS is actually used by SIDEHYD, but almost all of it and its subroutines are included as subroutines of SIDEHYD for fear that deleted some parts might adversely affect other parts. Some of the subroutines of THYSYS have been modified to include the effects of flap gates and Tideflex valves. Specifically, the subroutines RC40 and RC47 now have equivalents called RC40FLP and RC40FLX to account for flap gate and Tideflex valves on circular pipe culverts and RC47 has an equivalent RC47FLP to account for flap gates on box culverts.

The flow in each drainage culvert or for reverse flow in diversion culverts is determined by iterated calling of a subroutine named THYSYS, which was derived from a much larger, batch input program named THYSYS.F provided by the Texas Department of Transportation (TxDOT, 1977). THYSYS.F has numerous hydrologic and hydraulic calculation capabilities including the ability to determine the headwater elevation for a culvert given a design flow, resistance coefficient, culvert geometry, and tailwater elevation. Calculations follow a method developed by The Federal Highway Administration. A complete description of this method can be found in Chapter 4 of The Bridge Division Hydraulics Manual (Texas State Department of Highways and Public Transportation, 1985). For the purposes of this application, the stand-alone program, THYSYS.F, was converted to a subroutine, and a few of its capabilities not related to the present application were discarded. A capability to determine head losses due to flap gates and Tideflex gates (Lee and Holley, 2002) was added for this project.

The output from SIDEHYD.FOR is substantially similar to the output from the predecessor program SIDEHYDR. The ASCII output file SIDEHYD.OUT contains an additional column to indicate whether the flow is over the weir (W), through diversion culverts (D), through basin drainage culverts (C), or mixed (B).

4.2.14 - GP2.BAS

GP2.BAS is a Basic language graphics program. This program produces a graphical comparison of the assumed and computed diversion hydrographs. The program is called at the end of each iteration and allows the user to observe the progress of the iterative solution procedure. This Basic program is compiled Basic with GraphPack Professional (Crescent Software, undated) library and subroutine calls. The program terminates and SAS computations continue after a ten-second display unless a key is depressed by the user. Example output screens are presented in Fig. 3.12 and Fig. 3.14. On the monitor, the different curves have different colors. In the printed plots, different line formats are used.

4.2.15 - MOH1DF.FOR

MOH1DF.FOR is a Fortran program for modifying the HEC-1 input file by incorporating the results of the previous SIDEHYD run. It also checks the stopping criteria and writes the SCRIPT3.BAT file accordingly.

Major steps:

Open and read the CNTRL.DAT file.
Initialize the Q (discharge) arrays.
Get the filename of the HEC-1 base data file.
Read the HEC-1 time data.
Read ITIME (first hydrograph ordinate above threshold flow).
Read JTIME (last hydrograph ordinate above threshold flow).
Read the station numbers UPWEIR, ATWEIR, and DNWEIR.
Open the hydrograph list file and SIDEHYD output files for input.

Search for the upstream station in the hydrograph list.
Copy the hydrograph data into Q1 array.
Rewind the hydrograph list file.
Search for the ATWEIR station in the hydrograph list.
Copy the hydrograph data into Q2 array.
Find the table of calculated results in the SIDEHYD.OUT file.
Loop through all ordinates of interest.
Calculate interpolated SIDEHYD flow and store in Q3 array.
Compute the RMSE and the relative error statistics.
Write the error statistics to the SIDEHYD.HST file.
Close all files.
Open the error tolerance file to read RERNTOL.
If the relative error is greater than RERNTOL
then write SCRIPT3.BAT to reiterate
otherwise write SCRIPT3.BAT to produce final graph and stop.
Combine the HEC-1 base data file and the Q array data to produce the new HEC-1 data file.
Compute the flow at DNWEIR station.
Search for KK data set.
Having found a KK record check to see if it is the DNWEIR station.
Having found the DNWEIR KK record, first insert a new KK record group for the ATWEIR station.
Then insert the KK record group for the DNWEIR station.
Then search the base data file for the next KK record group.
Close the HEC1.DAT base data file and the MOH1DF.OUT file and end.

4.2.16 - MO2H1DF.FOR

MO2H1DF.FOR is a Fortran pre-processing program to merge the two HEC-1 base data files for the two-diversion case.

Major steps:

Open and read the CNTRL2.DAT file (the downstream weir).
Read the station numbers of the DNWEIR and ATWEIR stations.
Open the error tolerance file to read RERNTOL.
Open the SIDEHYD.HS1 and SIDEHYD.HS2 files to obtain the actual error.
If the maximum relative error is less than error tolerances, write SCRIPT3.BAT to plot final graphs and stop.
Otherwise write SCRIPT3.BAT to reiterate.
Open the two MOH1DF.OUT files for input and MOH1DF.OUT for output.
Read and copy the first file searching for the second weir DNWEIR station.
Read and skip in the second file until the ATWEIR station.
Read and copy until end of file.
Close all files and exit.

4.2.17 - GP3.BAS

GP3.BAS is a Basic language graphics program. This program produces a graphics display of the complete operation of the weir. The program is called as the final step in the procedure. The program is a compiled Basic program using GraphPack Professional library and subroutine calls (Crescent Software, undated). The graphs produced by GP3.BAS remain on the screen until a key is depressed by the user. For a one-weir problem or for the downstream diversion of a two-diversion problem, pressing a key returns to DOS. For the upstream diversion of a two-diversion problem, pressing a key causes GP3.BAS to generate the graph for the downstream diversion. Example output screens are presented in Fig. 3.13 and Fig. 3.15. On the monitor, the different curves have different colors. In the printed plots, different line formats are used.

4.3 - FUTURE MODIFICATIONS

The project work on developing the computational system and the reviews of this report identified some beneficial additions and changes that could not be pursued as part of the present project. Possible future modifications to the computational scheme are as follows:

- Modify the SAS control programs so that a specified keystroke would save the appropriate files at the end of an iteration for a "hot start" from the point at which the calculations were terminated and also modify the User Interface for allow for the hot start.
- Allow the user to specify a maximum number of iterations and save all input and output files for analysis.
- Develop a preprocessor program to check the input files for consistency, completeness, and accuracy.
- Provide the option of sending the graphics at the end of each iteration and at the end of the computations to an output file rather than to the screen so that the graphics will be available but will not take control of the screen at the end of each iteration.
- Include the parameter HOLD (Section 4.1.4) in the user interface to allow easier control of the time for which the graphics at the end of each iteration stay on the screen.

5 - REFERENCES

Crescent Software (undated) *GraphPak Professional* (User's Manual), Crescent Software, Inc., 11 Bailey Ave., Ridgefield, Conn., 06877

Davis, J. E. and Holley, E. R. (1988) "Modeling side-weir diversions for flood control," *Hydraulic Engineering, Proc., National Conf*. ASCE, pp. 979-984.

Lee, K.-L. and Holley, E. R. (2002) *Physical Modeling for Side-Channel Weirs*, Center for Research in Water Resources, Univ. of Texas, Austin, TX

TxDOT (1977) *THYSYS, User Manual for Texas Hydraulic System*, Texas Department of Transportation, Austin

U. S. Army Corps of Engineers (1990) HEC-1 User's Manual or http://www.hec.usace.army.mil/software/index.html

U. S. Army Corps of Engineers, (1994) HEC-2 User's Manual or http://www.hec.usace.army.mil/software/index.html

6 - APPENDICES

6.1 - SOURCE CODE LISTINGS

6.1.1 - SAS.FRM

SAS.FRM is the Visual Basic program for the User Interface for SAS. The purpose of this program is to acquire base input data filenames, UPWEIR, ATWEIR and DNWEIR station numbers, and hydrograph threshold discharge.

```
Version 1.00
BEGIN Form Khcd1
       AutoRedraw   = 0
       BackColor    = QBColor(15)
       BorderStyle  = 2
   Caption      = " SIDE-DIVERSION ANALYSIS SYSTEM  (v. 2.0)"
   ControlBox   = -1
   Enabled      = -1
   ForeColor    = QBColor(0)
   Height       = Char(23)
   Left         = Char(0)
   MaxButton    = -1
   MinButton    = -1
   MousePointer = 6
   Tag          = ""
   Top          = Char(1)
   Visible      = -1
   Width        = Char(80)
   WindowState  = 0
   BEGIN DriveListBox Drive1
      BackColor    = QBColor(15)
      DragMode     = 0
      Enabled      = -1
      ForeColor    = QBColor(0)
      Height       = Char(1)
      Left         = Char(48)
      MousePointer = 0
      TabIndex     = 11
      TabStop      = -1
      Tag          = ""
      Top          = Char(0)
      Visible      = -1
      Width        = Char(27)
   END
   BEGIN DirListBox Dir1
      BackColor    = QBColor(15)
      DragMode     = 0
      Enabled      = -1
      ForeColor    = QBColor(0)
      Height       = Char(6)
      Left         = Char(48)
      MousePointer = 0
      TabIndex     = 12
```

```
    TabStop      = -1
    Tag          = ""
    Top          = Char(1)
    Visible      = -1
    Width        = Char(26)
END
BEGIN TextBox Text1
    BackColor    = QBColor(15)
    BorderStyle  = 1
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    MultiLine    = 0
    ScrollBars   = 0
    TabIndex     = 0
    TabStop      = -1
    Tag          = ""
    Text         = ""
    Top          = Char(1)
    Visible      = -1
    Width        = Char(35)
END
BEGIN Label Label2
    Alignment    = 0
    AutoSize     = 0
    BackColor    = QBColor(15)
    BorderStyle  = 0
    Caption      = "HEC-2 INPUT FILENAME"
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    TabIndex     = 16
    Tag          = ""
    Top          = Char(2)
    Visible      = -1
    Width        = Char(25)
END
BEGIN TextBox Text2
    BackColor    = QBColor(15)
    BorderStyle  = 1
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    MultiLine    = 0
    ScrollBars   = 0
    TabIndex     = 1
    TabStop      = -1
    Tag          = ""
```

```
    Text         = ""
    Top          = Char(3)
    Visible      = -1
    Width        = Char(35)
END
BEGIN CommandButton Command4
    BackColor    = QBColor(15)
    Cancel       = 0
    Caption      = "CALC"
    Default      = 0
    DragMode     = 0
    Enabled      = -1
    Height       = Char(3)
    Left         = Char(49)
    MousePointer = 0
    TabIndex     = 14
    TabStop      = -1
    Tag          = ""
    Top          = Char(18)
    Visible      = -1
    Width        = Char(10)
END
BEGIN CommandButton Command1
    BackColor    = QBColor(15)
    Cancel       = 0
    Caption      = "EXIT"
    Default      = 0
    DragMode     = 0
    Enabled      = -1
    Height       = Char(3)
    Left         = Char(63)
    MousePointer = 0
    TabIndex     = 15
    TabStop      = -1
    Tag          = ""
    Top          = Char(18)
    Visible      = -1
    Width        = Char(10)
END
BEGIN FileListBox File1
    Archive      = -1
    BackColor    = QBColor(15)
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(11)
    Hidden       = 0
    Left         = Char(48)
    MousePointer = 0
    Normal       = -1
    Pattern      = "*.*"
    ReadOnly     = -1
    System       = 0
    TabIndex     = 13
    TabStop      = -1
    Tag          = ""
    Top          = Char(7)
```

```
    Visible      = -1
    Width        = Char(26)
END
BEGIN Label Label6
    Alignment    = 0
    AutoSize     = 0
    BackColor    = QBColor(15)
    BorderStyle  = 0
    Caption      = "SIDEHYD INPUT FILENAME"
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    TabIndex     = 20
    Tag          = ""
    Top          = Char(4)
    Visible      = -1
    Width        = Char(35)
END
BEGIN TextBox Text6
    BackColor    = QBColor(15)
    BorderStyle  = 1
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    MultiLine    = 0
    ScrollBars   = 0
    TabIndex     = 2
    TabStop      = -1
    Tag          = ""
    Text         = ""
    Top          = Char(5)
    Visible      = -1
    Width        = Char(35)
END
BEGIN TextBox Text8
    BackColor    = QBColor(15)
    BorderStyle  = 1
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    MultiLine    = 0
    ScrollBars   = 0
    TabIndex     = 3
    TabStop      = -1
    Tag          = ""
    Text         = ""
    Top          = Char(6)
    Visible      = -1
```

```
    Width        = Char(35)
END
BEGIN Label Label9
    Alignment    = 0
    AutoSize     = 0
    BackColor    = QBColor(15)
    BorderStyle  = 0
    Caption      = "1 or U/S D/S"
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(2)
    Left         = Char(37)
    MousePointer = 0
    TabIndex     = 23
    Tag          = ""
    Top          = Char(5)
    Visible      = -1
    Width        = Char(8)
END
BEGIN Label Label8
    Alignment    = 0
    AutoSize     = 0
    BackColor    = QBColor(15)
    BorderStyle  = 0
    Caption      = "HEC-1 INPUT FILENAME"
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    TabIndex     = 22
    Tag          = ""
    Top          = Char(0)
    Visible      = -1
    Width        = Char(25)
END
BEGIN TextBox Text4
    BackColor    = QBColor(15)
    BorderStyle  = 1
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    MultiLine    = 0
    ScrollBars   = 0
    TabIndex     = 7
    TabStop      = -1
    Tag          = ""
    Text         = ""
    Top          = Char(19)
    Visible      = -1
    Width        = Char(18)
END
```

```
BEGIN Label Label4
    Alignment    = 0
    AutoSize     = 0
    BackColor    = QBColor(15)
    BorderStyle  = 0
    Caption      = "HYDROGRAPH THRESHOLD (CFS)"
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    TabIndex     = 17
    Tag          = ""
    Top          = Char(18)
    Visible      = -1
    Width        = Char(30)
END
BEGIN TextBox Text5
    BackColor    = QBColor(15)
    BorderStyle  = 1
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    MultiLine    = 0
    ScrollBars   = 0
    TabIndex     = 6
    TabStop      = -1
    Tag          = ""
    Text         = ""
    Top          = Char(15)
    Visible      = -1
    Width        = Char(18)
END
BEGIN TextBox Text11
    BackColor    = QBColor(15)
    BorderStyle  = 1
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(22)
    MousePointer = 0
    MultiLine    = 0
    ScrollBars   = 0
    TabIndex     = 10
    TabStop      = -1
    Tag          = ""
    Text         = ""
    Top          = Char(15)
    Visible      = -1
    Width        = Char(18)
END
BEGIN Label Label5
```

```
    Alignment    = 0
    AutoSize     = 0
    BackColor    = QBColor(15)
    BorderStyle  = 0
    Caption      = "DNWEIR STATION NUMBER"
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    TabIndex     = 18
    Tag          = ""
    Top          = Char(14)
    Visible      = -1
    Width        = Char(25)
END
BEGIN TextBox Text7
    BackColor    = QBColor(15)
    BorderStyle  = 1
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    MultiLine    = 0
    ScrollBars   = 0
    TabIndex     = 5
    TabStop      = -1
    Tag          = ""
    Text         = ""
    Top          = Char(13)
    Visible      = -1
    Width        = Char(18)
END
BEGIN TextBox Text10
    BackColor    = QBColor(15)
    BorderStyle  = 1
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(22)
    MousePointer = 0
    MultiLine    = 0
    ScrollBars   = 0
    TabIndex     = 9
    TabStop      = -1
    Tag          = ""
    Text         = ""
    Top          = Char(13)
    Visible      = -1
    Width        = Char(18)
END
BEGIN Label Label7
    Alignment    = 0
```

```
    AutoSize     = 0
    BackColor    = QBColor(15)
    BorderStyle  = 0
    Caption      = "ATWEIR STATION NUMBER"
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    TabIndex     = 21
    Tag          = ""
    Top          = Char(12)
    Visible      = -1
    Width        = Char(25)
END
BEGIN TextBox Text3
    BackColor    = QBColor(15)
    BorderStyle  = 1
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(1)
    MousePointer = 0
    MultiLine    = 0
    ScrollBars   = 0
    TabIndex     = 4
    TabStop      = -1
    Tag          = ""
    Text         = ""
    Top          = Char(11)
    Visible      = -1
    Width        = Char(18)
END
BEGIN TextBox Text9
    BackColor    = QBColor(15)
    BorderStyle  = 1
    DragMode     = 0
    Enabled      = -1
    ForeColor    = QBColor(0)
    Height       = Char(1)
    Left         = Char(22)
    MousePointer = 0
    MultiLine    = 0
    ScrollBars   = 0
    TabIndex     = 8
    TabStop      = -1
    Tag          = ""
    Text         = ""
    Top          = Char(11)
    Visible      = -1
    Width        = Char(18)
END
BEGIN Label Label3
    Alignment    = 0
    AutoSize     = 0
```

```
        BackColor    = QBColor(15)
        BorderStyle  = 0
        Caption      = "1 or U/S DIVERSION   D/S DIVERSION  UPWEIR STATION NUMBER"
        DragMode     = 0
        Enabled      = -1
        ForeColor    = QBColor(0)
        Height       = Char(2)
        Left         = Char(1)
        MousePointer = 0
        TabIndex     = 19
        Tag          = ""
        Top          = Char(9)
        Visible      = -1
        Width        = Char(35)
    END
END
COMMON SHARED LF

SUB Command1_Click ()
IF LEN(TEXT8.TEXT) > 0 GOTO 200
100 REM CONTINUE
IF LEN(TEXT1.TEXT) = 0 GOTO 800
CLOSE (1)
OPEN "CNTRL.DAT" FOR OUTPUT AS #1
PRINT #1, "PROCESSED BY  :HCFCD"
PRINT #1, "TIME          :"; TIME$
PRINT #1, "DATE          :"; DATE$
PRINT #1, "HEC1.DAT      :"; TEXT1.TEXT
OPEN TEXT1.TEXT FOR INPUT AS #2
110 REM CONTINUE
LINE INPUT #2, A$
IF MID$(A$, 1, 2) = "IT" THEN GOTO 120
GOTO 110
120 REM CONTINUE
CLOSE (2)
IF INSTR(A$, ",") > 0 THEN A$ = MID$(A$, 3, 15)
IF INSTR(A$, ",") = 0 THEN A$ = LTRIM$(MID$(A$, 3, 6)) + "," + LTRIM$(MID$(A$, 9, 8)) + "," +
    LTRIM$(MID$(A$, 17, 8))
PRINT #1, "H1TIME        :"; A$
PRINT #1, "HEC2.DAT      :"; TEXT2.TEXT
PRINT #1, "SIDEHYD.DAT   :"; TEXT6.TEXT
PRINT #1, "UPWEIRSTA     :"; TEXT3.TEXT
PRINT #1, "HYDTHRESH     :"; TEXT4.TEXT
PRINT #1, "ITIME         :0"
PRINT #1, "JTIME         :0"
PRINT #1, "NH2FILES      :0"
PRINT #1, "DNWEIRSTA     :"; TEXT5.TEXT
PRINT #1, "WEIRSTA       :"; TEXT7.TEXT
PRINT #1, "ITERATION     :000"
CLOSE (1)
OPEN "SCRIPT0.BAT" FOR OUTPUT AS #1
REM PRINT #1, "@DEL HEC1.OUT"
REM PRINT #1, "@DEL RETRHYD.OUT"
PRINT #1, "HEC1.EXE INPUT="; TEXT1.TEXT; " OUTPUT=HEC1.OUT"
PRINT #1, "@DEL TAPE23"
PRINT #1, "@DEL TAPE24"
PRINT #1, "@DEL TAPE25"
```

```
PRINT #1, "C:\H1H2SH\RETRHYD.EXE"
PRINT #1, "COPY "; TEXT2.TEXT; " MOH2DF0.OUT"
PRINT #1, "C:\H1H2SH\MOH2DF1.EXE"
PRINT #1, "C:\H1H2SH\MOH2DF2.EXE"
PRINT #1, "C:\H1H2SH\CNTRL.EXE"
CLOSE (1)
OPEN "CNTRL1.DAT" FOR OUTPUT AS #1
CLOSE (1)
KILL "CNTRL1.DAT"
OPEN "CNTRL2.DAT" FOR OUTPUT AS #1
CLOSE (1)
KILL "CNTRL2.DAT"

OPEN "SCRIPT1.BAT" FOR OUTPUT AS #1
PRINT #1, "CLS"
CLOSE (1)
GOTO 900

200 REM CONTINUE
CLOSE (1)
OPEN "CNTRL1.DAT" FOR OUTPUT AS #1
OPEN "CNTRL2.DAT" FOR OUTPUT AS #2
PRINT #1, "PROCESSED BY  :KHCD1"
PRINT #2, "PROCESSED BY  :KHCD1"
PRINT #1, "TIME          :"; TIME$
PRINT #2, "TIME          :"; TIME$
PRINT #1, "DATE          :"; DATE$
PRINT #2, "DATE          :"; DATE$
PRINT #1, "HEC1.DAT      :"; TEXT1.TEXT
PRINT #2, "HEC1.DAT      :"; TEXT1.TEXT
OPEN TEXT1.TEXT FOR INPUT AS #3
210 REM CONTINUE
LINE INPUT #3, A$
IF MID$(A$, 1, 2) = "IT" THEN GOTO 220
GOTO 210
220 REM CONTINUE
CLOSE (3)
IF INSTR(A$, ",") > 0 THEN A$ = MID$(A$, 3, 15)
IF INSTR(A$, ",") = 0 THEN A$ = LTRIM$(MID$(A$, 3, 6)) + "," + LTRIM$(MID$(A$, 9, 8)) + "," +
   LTRIM$(MID$(A$, 17, 8))
PRINT #1, "H1TIME        :"; A$
PRINT #2, "H1TIME        :"; A$
PRINT #1, "HEC2.DAT      :"; TEXT2.TEXT
PRINT #2, "HEC2.DAT      :"; TEXT2.TEXT
PRINT #1, "SIDEHYD.DAT   :"; TEXT6.TEXT
PRINT #2, "SIDEHYD.DAT   :"; TEXT8.TEXT
PRINT #1, "UPWEIRSTA     :"; TEXT3.TEXT
PRINT #2, "UPWEIRSTA     :"; TEXT9.TEXT
PRINT #1, "HYDTHRESH     :"; TEXT4.TEXT
PRINT #2, "HYDTHRESH     :"; TEXT4.TEXT
PRINT #1, "ITIME         :0"
PRINT #2, "ITIME         :0"
PRINT #1, "JTIME         :0"
PRINT #2, "JTIME         :0"
PRINT #1, "NH2FILES      :0"
PRINT #2, "NH2FILES      :0"
PRINT #1, "DNWEIRSTA     :"; TEXT5.TEXT
```

```
PRINT #2, "DNWEIRSTA     :"; TEXT11.TEXT
PRINT #1, "WEIRSTA       :"; TEXT7.TEXT
PRINT #2, "WEIRSTA       :"; TEXT10.TEXT
PRINT #1, "ITERATION     :000"
PRINT #2, "ITERATION     :000"
CLOSE (1)
CLOSE (2)
OPEN "SCRIPT0.BAT" FOR OUTPUT AS #1
PRINT #1, "HEC1.EXE INPUT="; TEXT1.TEXT; " OUTPUT=HEC1.OUT"
PRINT #1, "@DEL TAPE23"
PRINT #1, "@DEL TAPE24"
PRINT #1, "@DEL TAPE25"
PRINT #1, "@COPY CNTRL1.DAT CNTRL.DAT"
PRINT #1, "C:\H1H2SH\RETRHYD.EXE"
PRINT #1, "COPY "; TEXT2.TEXT; " MOH2DF0.OUT"
PRINT #1, "C:\H1H2SH\MOH2DF1.EXE"
PRINT #1, "C:\H1H2SH\MOH2DF2.EXE"
PRINT #1, "@COPY CNTRL.DAT CNTRL1.DAT"
PRINT #1, "@DEL CNTRL.DAT"
PRINT #1, "C:\H1H2SH\KCNTRL.EXE"
CLOSE (1)
OPEN "CNTRL.DAT" FOR OUTPUT AS #1
CLOSE (1)
KILL "CNTRL.DAT"

800 REM CONTINUE
OPEN "SCRIPT1.BAT" FOR OUTPUT AS #1
PRINT #1, "CLS"
CLOSE (1)

900 REM CONTINUE
END
END SUB

SUB Command4_Click ()
IF LEN(TEXT8.TEXT) > 0 GOTO 1200
1100 REM CONTINUE
CLOSE (1)
OPEN "CNTRL.DAT" FOR OUTPUT AS #1
PRINT #1, "PROCESSED BY  :HCFCD"
PRINT #1, "TIME          :"; TIME$
PRINT #1, "DATE          :"; DATE$
PRINT #1, "HEC1.DAT      :"; TEXT1.TEXT
OPEN TEXT1.TEXT FOR INPUT AS #2
1110 REM CONTINUE
LINE INPUT #2, A$
IF MID$(A$, 1, 2) = "IT" THEN GOTO 1120
GOTO 1110
1120 REM CONTINUE
CLOSE (2)
IF INSTR(A$, ",") > 0 THEN A$ = MID$(A$, 3, 15)
IF INSTR(A$, ",") = 0 THEN A$ = LTRIM$(MID$(A$, 3, 6)) + "," + LTRIM$(MID$(A$, 9, 8)) + "," +
   LTRIM$(MID$(A$, 17, 8))
PRINT #1, "H1TIME        :"; A$
PRINT #1, "HEC2.DAT      :"; TEXT2.TEXT
PRINT #1, "SIDEHYD.DAT   :"; TEXT6.TEXT
PRINT #1, "UPWEIRSTA     :"; TEXT3.TEXT
```

```
PRINT #1, "HYDTHRESH     :"; TEXT4.TEXT
PRINT #1, "ITIME         :0"
PRINT #1, "JTIME         :0"
PRINT #1, "NH2FILES      :0"
PRINT #1, "DNWEIRSTA     :"; TEXT5.TEXT
PRINT #1, "WEIRSTA       :"; TEXT7.TEXT
PRINT #1, "ITERATION     :000"
CLOSE (1)
OPEN "SCRIPT1.BAT" FOR OUTPUT AS #1
REM PRINT #1, "@DEL HEC1.OUT"
REM PRINT #1, "@DEL RETRHYD.OUT"
PRINT #1, "HEC1.EXE INPUT="; TEXT1.TEXT; " OUTPUT=HEC1.OUT"
PRINT #1, "@DEL TAPE23"
PRINT #1, "@DEL TAPE24"
PRINT #1, "@DEL TAPE25"
PRINT #1, "C:\H1H2SH\RETRHYD.EXE"
PRINT #1, "COPY "; TEXT2.TEXT; " MOH2DF0.OUT"
PRINT #1, "C:\H1H2SH\MOH2DF1.EXE"
PRINT #1, "C:\H1H2SH\MOH2DF2.EXE"
PRINT #1, "C:\H1H2SH\CNTRL.EXE"
PRINT #1, "SCRIPT2.BAT"
CLOSE (1)
OPEN "CNTRL1.DAT" FOR OUTPUT AS #1
CLOSE (1)
KILL "CNTRL1.DAT"
OPEN "CNTRL2.DAT" FOR OUTPUT AS #1
CLOSE (1)
KILL "CNTRL2.DAT"
GOTO 1900

1200 REM CONTINUE
CLOSE (1)
OPEN "CNTRL1.DAT" FOR OUTPUT AS #1
OPEN "CNTRL2.DAT" FOR OUTPUT AS #2
PRINT #1, "PROCESSED BY  :KHCD1"
PRINT #2, "PROCESSED BY  :KHCD1"
PRINT #1, "TIME          :"; TIME$
PRINT #2, "TIME          :"; TIME$
PRINT #1, "DATE          :"; DATE$
PRINT #2, "DATE          :"; DATE$
PRINT #1, "HEC1.DAT      :"; TEXT1.TEXT
PRINT #2, "HEC1.DAT      :"; TEXT1.TEXT
OPEN TEXT1.TEXT FOR INPUT AS #3
10 REM CONTINUE
LINE INPUT #3, A$
IF MID$(A$, 1, 2) = "IT" THEN GOTO 20
GOTO 10
20 REM CONTINUE
CLOSE (3)
IF INSTR(A$, ",") > 0 THEN A$ = MID$(A$, 3, 15)
IF INSTR(A$, ",") = 0 THEN A$ = LTRIM$(MID$(A$, 3, 6)) + "," + LTRIM$(MID$(A$, 9, 8)) + "," +
   LTRIM$(MID$(A$, 17, 8))
PRINT #1, "H1TIME        :"; A$
PRINT #2, "H1TIME        :"; A$
PRINT #1, "HEC2.DAT      :"; TEXT2.TEXT
PRINT #2, "HEC2.DAT      :"; TEXT2.TEXT
PRINT #1, "SIDEHYD.DAT   :"; TEXT6.TEXT
```

```
PRINT #2, "SIDEHYD.DAT   :"; TEXT8.TEXT
PRINT #1, "UPWEIRSTA     :"; TEXT3.TEXT
PRINT #2, "UPWEIRSTA     :"; TEXT9.TEXT
PRINT #1, "HYDTHRESH     :"; TEXT4.TEXT
PRINT #2, "HYDTHRESH     :"; TEXT4.TEXT
PRINT #1, "ITIME         :0"
PRINT #2, "ITIME         :0"
PRINT #1, "JTIME         :0"
PRINT #2, "JTIME         :0"
PRINT #1, "NH2FILES      :0"
PRINT #2, "NH2FILES      :0"
PRINT #1, "DNWEIRSTA     :"; TEXT5.TEXT
PRINT #2, "DNWEIRSTA     :"; TEXT11.TEXT
PRINT #1, "WEIRSTA       :"; TEXT7.TEXT
PRINT #2, "WEIRSTA       :"; TEXT10.TEXT
PRINT #1, "ITERATION     :000"
PRINT #2, "ITERATION     :000"
CLOSE (1)
CLOSE (2)
OPEN "SCRIPT1.BAT" FOR OUTPUT AS #1
REM PRINT #1, "@DEL HEC1.OUT"
REM PRINT #1, "@DEL RETRHYD.OUT"
PRINT #1, "HEC1.EXE INPUT="; TEXT1.TEXT; " OUTPUT=HEC1.OUT"
PRINT #1, "@DEL TAPE23"
PRINT #1, "@DEL TAPE24"
PRINT #1, "@DEL TAPE25"
PRINT #1, "@COPY CNTRL1.DAT CNTRL.DAT"
PRINT #1, "C:\H1H2SH\RETRHYD.EXE"
PRINT #1, "COPY "; TEXT2.TEXT; " MOH2DF0.OUT"
PRINT #1, "C:\H1H2SH\MOH2DF1.EXE"
PRINT #1, "C:\H1H2SH\MOH2DF2.EXE"
PRINT #1, "@COPY CNTRL.DAT CNTRL1.DAT"
PRINT #1, "@DEL CNTRL.DAT"
PRINT #1, "C:\H1H2SH\KCNTRL.EXE"
PRINT #1, "SCRIPT2.BAT"
CLOSE (1)
OPEN "CNTRL.DAT" FOR OUTPUT AS #1
CLOSE (1)
KILL "CNTRL.DAT"

1900 REM CONTINUE
END
END SUB

SUB Dir1_Change ()
File1.Path = Dir1.Path
END SUB

SUB Dir1_KeyPress (KeyAscii AS INTEGER)
Dir1.Path = Dir1.List(Dir1.Listindex)
END SUB

SUB Drive1_Change ()
ON LOCAL ERROR GOTO 4800
CHDRIVE Drive1.drive
Dir1.Path = Drive1.drive
GOTO 4890
```

```
4800 REM CONTINUE
Drive1.drive = "C"
CHDRIVE "C"
RESUME
4890 REM CONTINUE
END SUB

SUB File1_Click ()
IF LF <= 0 THEN LF = 1
IF LF = 1 THEN
   TEXT1.TEXT = Dir1.Path + "\" + File1.FILENAME
   END IF
IF LF = 2 THEN
   TEXT2.TEXT = Dir1.Path + "\" + File1.FILENAME
   END IF
IF LF = 6 THEN
   TEXT6.TEXT = Dir1.Path + "\" + File1.FILENAME
   END IF
IF LF = 8 THEN
   TEXT8.TEXT = Dir1.Path + "\" + File1.FILENAME
   END IF
END SUB

SUB File1_KeyPress (KeyAscii AS INTEGER)
IF LF <= 0 THEN LF = 1
IF LF = 3 THEN LF = 1
IF LF = 4 THEN LF = 1
IF LF = 5 THEN LF = 1


IF LF = 1 THEN
   IF File1.FILENAME <> "" THEN TEXT1.TEXT = Dir1.Path + "\" + File1.FILENAME
   TEXT2.SETFOCUS
   END IF
IF LF = 2 THEN
   IF File1.FILENAME <> "" THEN TEXT2.TEXT = Dir1.Path + "\" + File1.FILENAME
   TEXT6.SETFOCUS
   END IF
IF LF = 6 THEN
   IF File1.FILENAME <> "" THEN TEXT6.TEXT = Dir1.Path + "\" + File1.FILENAME
   TEXT8.SETFOCUS
   END IF
IF LF = 8 THEN
   IF File1.FILENAME <> "" THEN TEXT8.TEXT = Dir1.Path + "\" + File1.FILENAME
   TEXT3.SETFOCUS
   END IF

END SUB

SUB Form_Click ()

END SUB

SUB Label1_Change ()

END SUB
```

```
SUB Label6_Change ()

END SUB

SUB Text10_KeyPress (KeyAscii AS INTEGER)
IF KeyAscii = 13 THEN TEXT11.SETFOCUS
END SUB

SUB Text11_KeyPress (KeyAscii AS INTEGER)
IF KeyAscii = 13 THEN COMMAND4.SETFOCUS
END SUB

SUB Text1_GotFocus ()
IF LF <> 0 GOTO 8
ON LOCAL ERROR GOTO 2
OPEN "CNTRL1.DAT" FOR INPUT AS #1
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
TEXT1.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
LINE INPUT #1, A$
TEXT2.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
TEXT6.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
TEXT3.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
TEXT4.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
TEXT5.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
TEXT7.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
CLOSE (1)
OPEN "CNTRL2.DAT" FOR INPUT AS #1
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
TEXT8.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
TEXT9.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
TEXT11.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
TEXT10.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
```

```
CLOSE (1)
GOTO 8

2 REM CONTINUE
RESUME 3
3 REM CONTINUE
ON LOCAL ERROR GOTO 7
OPEN "CNTRL.DAT" FOR INPUT AS #1
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
TEXT1.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
LINE INPUT #1, A$
TEXT2.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
TEXT6.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
TEXT3.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
TEXT4.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
LINE INPUT #1, A$
TEXT5.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
LINE INPUT #1, A$
TEXT7.TEXT = MID$(RTRIM$(A$), 16, LEN(RTRIM$(A$)) - 15)
CLOSE (1)
GOTO 8
7 REM CONTINUE
RESUME 8
8 REM CONTINUE
LF = 1
9 REM CONTINUE
END SUB

SUB Text1_KeyPress (KeyAscii AS INTEGER)
IF KeyAscii = 13 AND TEXT1.TEXT = "" THEN File1.SETFOCUS
IF KeyAscii = 13 AND TEXT1.TEXT <> "" THEN TEXT2.SETFOCUS
END SUB

SUB Text2_GotFocus ()
LF = 2
END SUB

SUB Text2_KeyPress (KeyAscii AS INTEGER)
IF KeyAscii = 13 AND TEXT2.TEXT = "" THEN File1.SETFOCUS
IF KeyAscii = 13 AND TEXT2.TEXT <> "" THEN TEXT6.SETFOCUS
END SUB

SUB Text3_GotFocus ()
LF = 3
END SUB

SUB Text3_KeyPress (KeyAscii AS INTEGER)
```

```
IF KeyAscii = 13 THEN TEXT7.SETFOCUS
END SUB

SUB Text4_GotFocus ()
LF = 4
END SUB

SUB Text4_KeyPress (KeyAscii AS INTEGER)
IF KeyAscii = 13 THEN TEXT9.SETFOCUS
END SUB

SUB Text5_GotFocus ()
LF = 5
END SUB

SUB Text5_KeyPress (KeyAscii AS INTEGER)
IF KeyAscii = 13 THEN TEXT4.SETFOCUS
END SUB

SUB Text6_Change ()

END SUB

SUB Text6_GotFocus ()
LF = 6
END SUB

SUB Text6_KeyPress (KeyAscii AS INTEGER)
IF KeyAscii = 13 AND TEXT6.TEXT = "" THEN File1.SETFOCUS
IF KeyAscii = 13 AND TEXT6.TEXT <> "" THEN TEXT8.SETFOCUS

END SUB

SUB Text7_GotFocus ()
LF = 7
END SUB

SUB Text7_KeyPress (KeyAscii AS INTEGER)
IF KeyAscii = 13 THEN TEXT5.SETFOCUS
END SUB

SUB Text8_Change ()

END SUB

SUB Text8_GotFocus ()
LF = 8

END SUB

SUB Text8_KeyPress (KeyAscii AS INTEGER)
IF KeyAscii = 13 AND TEXT8.TEXT = "" THEN File1.SETFOCUS
IF KeyAscii = 13 AND TEXT8.TEXT <> "" THEN TEXT3.SETFOCUS

END SUB

SUB Text9_KeyPress (KeyAscii AS INTEGER)
```

```
IF KeyAscii = 13 THEN TEXT10.SETFOCUS
END SUB
```

6.1.2 - RETRHYD.FOR

RETRHYD.FOR is a Fortran program for retrieving and manipulating hydrographs from the HEC-1 output files and reformatting them to be consistent with SAS.

```
C     PROGRAM RETRHYD.FOR
C
C     PURPOSE         : TO RETRIEVE COMPUTED HYDROGRAPHS
C                       FROM THE HEC1 OUTPUT AND REFORMAT
C     INVOKED BY      : SCRIPT1.BAT THE FIRST TIME
C                       AND SCRIPT3.BAT THEREAFTER
C     INPUT REQUIRED  : HEC1.OUT
C     OUTPUT PRODUCED : RETRHYD.OUT
C
      CHARACTER*132 ALINE
      CHARACTER*1   BLINE
      CHARACTER*19  ADLR
      DIMENSION BLINE(132)
      DIMENSION Q(300)
      DIMENSION ADLR(300)
C
      OPEN(1,FILE='HEC1.OUT')
      OPEN(2,FILE='RETRHYD.OUT')
C
CJFB  WRITE(*,10)
10    FORMAT(1X,  '******************************',/,
     .       1X,  '* PROGRAM RETRHYD.FOR        *',/,
     .       1X,  '* RETRIEVE HYDROGRAPHS       *',/,
     .       1X,  '* VERSION 12/26/95           *',/,
     .       1X,  '******************************',/)
C
      CALL GETDAT(IYR,IMON,IDAY)
      IYR=IYR-1900
      CALL GETTIM(IHR,IMIN,ISEC,I100TH)
      WRITE(*,11)IMON,IDAY,IYR,IHR,IMIN,ISEC
      WRITE(2,11)IMON,IDAY,IYR,IHR,IMIN,ISEC
11    FORMAT(1X,'RETRHYD.FOR     ',I2.2,'/',I2.2,'/',I2.2,
     .              2X,I2.2,':',I2.2,':',I2.2,)
C
C
C     READ THE HEC1 OUTPUT FILE AND SKIP LINES UNTIL "INTERPOLATED"
C     THEN GO TO 200
C
100   CONTINUE
      READ(1,110,END=500)ALINE
110   FORMAT(A132)
C
      I=INDEX(ALINE,'INTERPOLATED')
C
      IF(I.EQ.0)GO TO 100
C
200   CONTINUE
      DO 205 I=1,132
      BLINE(I)=' '
205   CONTINUE
```

```
C
C     LOCATE THE CHARACTER POSITION OF THE WORD "HYDROGRAPH"
C
      J=INDEX(ALINE,'HYDROGRAPH')
      READ(ALINE,210)(BLINE(I),I=1,132)
210   FORMAT(132A1)
C
C     WRITE THE HYDROGRAPH STATION ID TO RETRHYD.OUT
C
      WRITE(2,220)(BLINE(I),I=J,132)
220   FORMAT(1X,132A1)
C
C     SKIP THE NEXT FIVE LINES IN THE HEC1 OUTPUT
C
      DO 230 I=1,5
      READ(1,110)ALINE
230   CONTINUE
C
C     READ THE DATA SET (TIME AND FLOW) FROM THE 8X75 HEC1 OUTPUT TABLE
C
      DO 250 I=1,75
      J=I+75
      K=J+75
      L=K+75
      READ(1,240)ADLR(I),Q(I),ADLR(J),Q(J),ADLR(K),Q(K),ADLR(L),Q(L)
240   FORMAT(1X,A19,F10.0,4X,A19,F10.0,4X,A19,F10.0,4X,A19,F10.0)
250   CONTINUE
C
C
300   CONTINUE
C
C     WRITE THE DATA SET TO OUTPUT IN 2X300 FORMAT
C
      DO 320 I=1,300
      WRITE(2,310)ADLR(I),Q(I)
310   FORMAT(1X,A19,F15.2)
320   CONTINUE
C
C
400   CONTINUE
C
C     RETURN TO THE BEGINNING
C
      GO TO 100
C
500   CONTINUE
C
C     CLOSE FILES AND EXIT
C
      CLOSE(1)
      CLOSE(2)
      END
```

6.1.3 - MOH2DF0.FOR

MOH2DF0.FOR is a Fortran program to insert a cross section in the HEC-2 data file at the UPWEIR station for problems with one weir.

```
C     PROGRAM MOH2DF0.FOR
C
C     PURPOSE         : TO INSERT A CROSS SECTION AT THE UPWEIR STATTION
C     INVOKED BY      : SCRIPT1.BAT THE FIRST TIME AND SCRIPT3.BAT AFTER
C     INPUT REQUIRED  : CNTRL.DAT <HEC2.DAT> <SIDEHYD.DAT>
C     OUTPUT PRODUCED : MOH2DF0.OUT
C
C
      CHARACTER*70 L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14,L15
      CHARACTER*35 JFILE
      CHARACTER*132 ILINE,JLINE
      CHARACTER*1 KLINE
      CHARACTER*80 ADLR
      CHARACTER*20 CDLR
      DIMENSION KLINE(132)
C
C     READ THE CONTROL FILE
C
      OPEN(4,FILE='CNTRL.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
10    FORMAT(A50)
12    FORMAT(19A1)
C
      CLOSE(4)
C
C     GET THE NAME OF THE HEC2 BASE DATA FILE
C
      READ(L6,20)JFILE
20    FORMAT(15X,A35)
C
C     READ THE STATION NUMBERS UPSTREAM DOWNSTREAM AND AT WEIR
C
      READ(L8,40)IUSTA
      READ(L13,40)IDSTA
      READ(L14,40)IWSTA
40    FORMAT(15X,I15)
```

```
C
C     OPEN THE HEC2 BASE DATA FILE
C
      OPEN(1,FILE=JFILE)
C
C     OPEN THE OUTPUT FILE FOR THIS PROGRAM
C
      OPEN(2,FILE='MOH2DF0.OUT')
C
CJFB  WRITE(*,50)
50    FORMAT(1X,  '******************************',/,
     .       1X,  '* PROGRAM MOH2DF0.FOR        *',/,
     .       1X,  '* ADD UPWEIR STA TO HEC2.DAT *',/,
     .       1X,  '* VERSION 07/10/96           *',/,
     .       1X,  '******************************',/)
C
      CALL GETDAT(IYR,IMO,IDA)
      CALL GETTIM(IHR,IMI,ISE,I100TH)
      WRITE(*,51)IMO,IDA,IYR,IHR,IMI,ISE
51    FORMAT(2H* ,'MOH2DF0.FOR     ',I2.2,'/',I2.2,'/',I4.4,
     .              2X,I2.2,':',I2.2,':',I2.2)
C
C     READ LINES IN THE HEC2 BASE DATA FILE
C
200   CONTINUE
      READ(1,210,END=900)ILINE
210   FORMAT(A132)
C
C     PROCESS X1 CARDS AT 300
C
      IF(INDEX(ILINE,'X1').EQ.1)GO TO 300
C
C     PROCESS ALL OTHER CARDS AT 500
C
      GO TO 500
C
C
C
300   CONTINUE
C
C     READ THE STATION NUMBER FROM THE BASE DATA FILE
C
      READ(ILINE,305)ISTA
305   FORMAT(2X,I6)
C
C     IF IT IS GT THE DNWEIR STATION   PROCESS AT 600
C
      IF(ISTA.GT.IDSTA)GO TO 600
C
C     OTHERWISE... FALL THROUGH
C
500   CONTINUE
C
C     WRITE THE CARD TO OUTPUT
C
      WRITE(2,510)ILINE
510   FORMAT(A132)
```

```
C
C     RETURN TO TOP
C
      GO TO 200
C
600   CONTINUE
C
C     OPEN THE SIDEHYD BASE DATA FILE. GET THE CROSS SECTION CHARACTERISTICS.
C
      READ(L7,620)JFILE
620   FORMAT(15X,A35)
      OPEN(3,FILE=JFILE)
C
      READ(3,621)KLINE(1)
621   FORMAT(A1)
      READ(3,*)N
      DO 630 I=1,N
      READ(3,621)KLINE(1)
630   CONTINUE
      READ(3,*) IMON
      READ(3,*) CWIDTH, SS, SZ, ZD, AMANN
CJFB  READ(3,*) WRP, WRLEN, WRW, WRES
C
      READ(3,631)ADLR
631   FORMAT(A80)
      IF(INDEX(ADLR,"CULV").GT.0)THEN
         CALL JSTR(ADLR,CDLR)
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRP
632      FORMAT(F20.0)
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRLEN
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRW
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRES
         GO TO 635
         ENDIF
      IF(INDEX(ADLR,"WEIR").GT.0)THEN
         CALL JSTR(ADLR,CDLR)
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRP
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRLEN
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRW
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRES
         GO TO 635
         ENDIF
C        PROCESS ORIGINAL FORMAT
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRP
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRLEN
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRW
```

```
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,632)WRES
C
635   CONTINUE
      CLOSE(3)
C
      ELDELTA=WRLEN*SZ
      IWRLEN=INT(WRLEN+0.5)
      WRITE(2,640)IUSTA,IWRLEN,IWRLEN,IWRLEN,ELDELTA
640   FORMAT('X1',I6,'       0                ',3I8,8X,F8.2)
      WRITE(2,650)
650   FORMAT('CI')
C
C     RECALCULATE DISTANCES ON THE REACH
C
      READ(ILINE,660)IF1,IF2,IF3,IF4,IF5,IF6,IF7,IF8,IF9,IF10
660   FORMAT(2X,10I8)
      IF5=IF5-IWRLEN
      IF6=IF6-IWRLEN
      IF7=IF7-IWRLEN
      IF(IF5.LT.0)IF5=0
      IF(IF6.LT.0)IF6=0
      IF(IF7.LT.0)IF7=0
C
C     PRINT OUT THE MODIFIED X1 CARD THAT FOLLOWS THE UPWEIR STATION
C
      WRITE(2,670)IF1,IF2,IF3,IF4,IF5,IF6,IF7,IF8,IF9,IF10
670   FORMAT('X1',I6,9I8)
C
800   CONTINUE
      READ(1,810,END=900)ILINE
      WRITE(2,810)ILINE
810   FORMAT(A132)
      GO TO 800
900   CONTINUE
C
C     CLOSE ALL FILES
C
      CLOSE(1)
      CLOSE(2)
1000  CONTINUE
      END
C
      SUBROUTINE JSTR(ADLR,CDLR)
      CHARACTER*80 ADLR
      CHARACTER*20 CDLR
      CHARACTER*1 BDLR
      DIMENSION BDLR(80)
C
      CDLR=" "
      READ(ADLR,10)(BDLR(I),I=1,80)
10    FORMAT(80A1)
C
      DO 20 I=1,80
      IF(BDLR(I).EQ.",")BDLR(I)=" "
      IF(BDLR(I).EQ."'")BDLR(I)=" "
20    CONTINUE
```

```
C
      DO 30 I=1,80
      ICF=I
      IF(BDLR(I).NE." ")GO TO 35
30    CONTINUE
      GO TO 90
35    CONTINUE
      DO 40 I=ICF,80
      ICL=I
      IF(BDLR(I).EQ." ")GO TO 45
40    CONTINUE
      ICL=ICL+1
45    CONTINUE
      ICL=ICL-1
C
      WRITE(ADLR,50)(BDLR(I),I=ICL+1,80)
50    FORMAT(80A1)
      WRITE(CDLR,60)(BDLR(I),I=ICF,ICL)
60    FORMAT(20A1)
90    CONTINUE
      RETURN
      END
```

6.1.4 - MOH2DFK.FOR

MOH2DFK.FOR for two weirs is similar to MOH2DF0.FOR for one weir. It inserts a cross section in the HEC-2 data file at the UPWEIR station for both weirs.

```
C     PROGRAM MOH2DFK.FOR
C
C     PURPOSE         : TO INSERT A CROSS SECTION AT THE 2 UPWEIR STATIONS
C     INVOKED BY      : SCRIPT1.BAT THE FIRST TIME AND SCRIPT3.BAT THEREAFTER
C     INPUT REQUIRED  : <HEC2.DAT> <SIDEHYD.DAT> CNTRL1.DAT CNTRL2.DAT
C     OUTPUT PRODUCED : MOH2DF0.OUT
C
      CHARACTER*70 L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14,L15
      CHARACTER*35 JFILE
      CHARACTER*132 ILINE
      CHARACTER*1 KLINE
      CHARACTER*80 ADLR
      CHARACTER*20 CDLR
      DIMENSION KLINE(132)
C
C     READ THE CONTROL FILE
C
      OPEN(4,FILE='CNTRL2.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
10    FORMAT(A50)
12    FORMAT(19A1)
C
      CLOSE(4)
C
C     GET THE NAME OF THE HEC2 BASE DATA FILE
C
      READ(L6,20)JFILE
20    FORMAT(15X,A35)
C
C     READ THE STATION NUMBERS UPSTREAM DOWNSTREAM AND AT WEIR
C
      READ(L8,40)IUSTA
      READ(L13,40)IDSTA
      READ(L14,40)IWSTA
40    FORMAT(15X,I15)
C
```

```
C     OPEN THE HEC2 BASE DATA FILE
C
      OPEN(1,FILE=JFILE)
      OPEN(2,FILE='MOH2DF0.OUT')
C
CJFB  WRITE(*,50)
50    FORMAT(1X,  '******************************',/,
     .       1X,  '* PROGRAM MOH2DFK.FOR        *',/,
     .       1X,  '* ADD UPWEIR STA TO HEC2.DAT *',/,
     .       1X,  '* VERSION 07/10/96           *',/,
     .       1X,  '******************************',/)
C
      CALL GETDAT(IYR,IMO,IDA)
      CALL GETTIM(IHR,IMI,ISE,I100TH)
      WRITE(*,51)IMO,IDA,IYR,IHR,IMI,ISE
51    FORMAT(2H* ,'MOH2DFK.FOR     ',I2.2,'/',I2.2,'/',I4.4,
     .              2X,I2.2,':',I2.2,':',I2.2)
C
C     READ LINES IN THE HEC2 BASE DATA FILE
C
200   CONTINUE
      READ(1,210,END=9000)ILINE
210   FORMAT(A132)
C
C     PROCESS X1 CARDS AT 300
C
      IF(INDEX(ILINE,'X1').EQ.1)GO TO 300
C
C     PROCESS ALL OTHER CARDS AT 500
C
      GO TO 500
C
C
C
300   CONTINUE
C
C     READ THE STATION NUMBER FROM THE BASE DATA FILE
C
      READ(ILINE,305)ISTA
305   FORMAT(2X,I6)
C
C     IF IT IS EQ TO THE UPWEIR STATION   PROCESS AT 600
C              GT    THE UPWEIR STATION   PROCESS AT 700
C
      IF(ISTA.EQ.IUSTA)GO TO 600
      IF(ISTA.GT.IUSTA)GO TO 700
C
C     OTHERWISE...
C
500   CONTINUE
C
C     WRITE THE CARD TO OUTPUT
C
      WRITE(2,210)ILINE
C
C     RETURN TO TOP
C
```

```
      GO TO 200
C
600   CONTINUE
C
C     WRITE THE LINE TO OUTPUT
C
      WRITE(2,210)ILINE
      GO TO 1000
C
700   CONTINUE
C
C     OPEN THE SIDEHYD BASE DATA FILE. GET THE CROSS SECTION CHARACTERISTICS.
C
      READ(L7,720)JFILE
720   FORMAT(15X,A35)
      OPEN(3,FILE=JFILE)
C
      READ(3,721)KLINE(1)
721   FORMAT(A1)
      READ(3,*)N
      DO 730 I=1,N
      READ(3,721)KLINE(1)
730   CONTINUE
      READ(3,*) IMON
      READ(3,*) CWIDTH, SS, SZ, ZD, AMANN
CJFB  READ(3,*) WRP, WRLEN, WRW, WRES
      READ(3,731)ADLR
731   FORMAT(A80)
      IF(INDEX(ADLR,"CULV").GT.0)THEN
     CALL JSTR(ADLR,CDLR)
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRP
732      FORMAT(F20.0)
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRLEN
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRW
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRES
     GO TO 735
     ENDIF
      IF(INDEX(ADLR,"WEIR").GT.0)THEN
     CALL JSTR(ADLR,CDLR)
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRP
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRLEN
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRW
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRES
     GO TO 735
     ENDIF
C        PROCESS ORIGINAL FORMAT
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRP
     CALL JSTR(ADLR,CDLR)
```

```
     READ(CDLR,732)WRLEN
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRW
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRES
C
735   CONTINUE
      CLOSE(3)
C
      ELDELTA=WRLEN*SZ
      IWRLEN=INT(WRLEN+0.5)
      WRITE(2,740)IUSTA,IWRLEN,IWRLEN,IWRLEN,ELDELTA
740   FORMAT('X1',I6,'       0                 ',3I8,8X,F8.2)
      WRITE(2,750)
750   FORMAT('CI')
C
C     RECALCULATE DISTANCES ON THE REACH
C
      READ(ILINE,760)IF1,IF2,IF3,IF4,IF5,IF6,IF7,IF8,IF9,IF10
760   FORMAT(2X,10I8)
      IF5=IF5-IWRLEN
      IF6=IF6-IWRLEN
      IF7=IF7-IWRLEN
      IF(IF5.LT.0)IF5=0
      IF(IF6.LT.0)IF6=0
      IF(IF7.LT.0)IF7=0
C
C     PRINT OUT THE MODIFIED X1 CARD THAT FOLLOWS THE UPWEIR STATION
C
      WRITE(2,770)IF1,IF2,IF3,IF4,IF5,IF6,IF7,IF8,IF9,IF10
770   FORMAT('X1',I6,9I8)
C
      GO TO 1000

1000  CONTINUE
C
C     READ THE OTHER CONTROL FILE
C
      OPEN(4,FILE='CNTRL1.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
      CLOSE(4)
C
C     GET THE NAME OF THE HEC2 BASE DATA FILE
```

```
C
      READ(L6,20)JFILE
C
C     READ THE STATION NUMBERS UPSTREAM DOWNSTREAM AND AT WEIR
C
      READ(L8,40)IUSTA
      READ(L13,40)IDSTA
      READ(L14,40)IWSTA
C
C     CONTINUE TO READ LINES IN THE HEC2 BASE DATA FILE
C
1200  CONTINUE
      READ(1,210,END=9000)ILINE
C
C     PROCESS X1 CARDS AT 1300
C
      IF(INDEX(ILINE,'X1').EQ.1)GO TO 1300
C
C     PROCESS ALL OTHER CARDS AT 1500
C
      GO TO 1500
C
C
C
1300  CONTINUE
C
C     READ THE STATION NUMBER FROM THE BASE DATA FILE
C
      READ(ILINE,305)ISTA
C
C     IF IT IS EQ TO THE UPWEIR STATION   PROCESS AT 1600
C              GT    THE UPWEIR STATION   PROCESS AT 1700
C
      IF(ISTA.EQ.IUSTA)GO TO 1600
      IF(ISTA.GT.IUSTA)GO TO 1700
C
C     OTHERWISE...
C
1500   CONTINUE
C
C     WRITE THE CARD TO OUTPUT
C
      WRITE(2,210)ILINE
C
C     RETURN TO TOP
C
      GO TO 1200
C
1600  CONTINUE
C
C     WRITE THE LINE TO OUTPUT
C
      WRITE(2,210)ILINE
      GO TO 2000
C
1700  CONTINUE
C
```

```
C     OPEN THE SIDEHYD BASE DATA FILE. GET THE CROSS SECTION CHARACTERISTICS.
C
      READ(L7,720)JFILE
      OPEN(3,FILE=JFILE)
C
      READ(3,721)KLINE(1)
      READ(3,*)N
      DO 1730 I=1,N
      READ(3,721)KLINE(1)
1730  CONTINUE
      READ(3,*) IMON
      READ(3,*) CWIDTH, SS, SZ, ZD, AMANN
CJFB  READ(3,*) WRP, WRLEN, WRW, WRES
      READ(3,731)ADLR
C
      IF(INDEX(ADLR,"CULV").GT.0)THEN
     CALL JSTR(ADLR,CDLR)
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRP
C
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRLEN
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRW
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRES
     GO TO 1735
     ENDIF
      IF(INDEX(ADLR,"WEIR").GT.0)THEN
     CALL JSTR(ADLR,CDLR)
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRP
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRLEN
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRW
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRES
     GO TO 1735
     ENDIF
C       PROCESS ORIGINAL FORMAT
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRP
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRLEN
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRW
     CALL JSTR(ADLR,CDLR)
     READ(CDLR,732)WRES
C
1735  CONTINUE

      CLOSE(3)
C
      ELDELTA=WRLEN*SZ
      IWRLEN=INT(WRLEN+0.5)
      WRITE(2,740)IUSTA,IWRLEN,IWRLEN,IWRLEN,ELDELTA
```

```
      WRITE(2,750)
C
C     RECALCULATE DISTANCES ON THE REACH
C
      READ(ILINE,760)IF1,IF2,IF3,IF4,IF5,IF6,IF7,IF8,IF9,IF10
      IF5=IF5-IWRLEN
      IF6=IF6-IWRLEN
      IF7=IF7-IWRLEN
      IF(IF5.LT.0)IF5=0
      IF(IF6.LT.0)IF6=0
      IF(IF7.LT.0)IF7=0
C
C     PRINT OUT THE MODIFIED X1 CARD THAT FOLLOWS THE UPWEIR STATION
C
      WRITE(2,770)IF1,IF2,IF3,IF4,IF5,IF6,IF7,IF8,IF9,IF10
C
      GO TO 2000
C
2000  CONTINUE
      READ(1,210,END=9000)ILINE
      WRITE(2,210)ILINE
      GO TO 2000
C
9000  CONTINUE
      CLOSE(1)
      CLOSE(2)
C
      END
      SUBROUTINE JSTR(ADLR,CDLR)
      CHARACTER*80 ADLR
      CHARACTER*20 CDLR
      CHARACTER*1 BDLR
      DIMENSION BDLR(80)
C
      CDLR=" "
      READ(ADLR,10)(BDLR(I),I=1,80)
10    FORMAT(80A1)
C
      DO 20 I=1,80
      IF(BDLR(I).EQ.",")BDLR(I)=" "
      IF(BDLR(I).EQ."'")BDLR(I)=" "
20    CONTINUE
C
      DO 30 I=1,80
      ICF=I
      IF(BDLR(I).NE." ")GO TO 35
30    CONTINUE
      GO TO 90
35    CONTINUE
      DO 40 I=ICF,80
      ICL=I
      IF(BDLR(I).EQ." ")GO TO 45
40    CONTINUE
      ICL=ICL+1
45    CONTINUE
      ICL=ICL-1
C
```

```
      WRITE(ADLR,50)(BDLR(I),I=ICL+1,80)
50    FORMAT(80A1)
      WRITE(CDLR,60)(BDLR(I),I=ICF,ICL)
60    FORMAT(20A1)
90    CONTINUE
      RETURN
      END
```

6.1.5 - MOH2DF1.FOR

MOH2DF1.FOR is a Fortran program for finding ITIME and JTIME for beginning and end, respectively, of flow above threshold at the UPWEIR station (for the upstream weir, if there are two weirs), for making J3 and QT modifications to HEC-2 input data, and for adding time information to the CNTRL.DAT file.

```
C     PROGRAM MOH2DF1.FOR
C
C
C     PURPOSE         : TO FIND ITIME AND JTIME FLOW ABOVE THRESHOLD
C                       AT UPWEIR
C                       TO MAKE J3 & QT MODIFICATIONS TO HEC2 INPUT DATA
C                       TO ADD TIME INFORMATION TO THE CNTRL.DAT FILE
C     INVOKED BY      : SCRIPT1.BAT THE FIRST TIME AND SCRIPT3.BAT AFTER
C     INPUT REQUIRED  : CNTRL.DAT (FOR 2 WEIRS CNTRL1.DAT & CNTRL2.DAT)
C                       MOH2DF0.OUT RETRHYD.OUT RERNTOL.DAT
C                       SIDEHYD.PLT (FOR TWO WEIRS SIDEHYD.PL1 & SIDEHYD.PL2)
C     OUTPUT PRODUCED : MOH2DF1.OUT CNTRL.DAT
C
      CHARACTER*70 L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14,L15
      CHARACTER*35 JFILE
      CHARACTER*132 ILINE,JLINE
      CHARACTER*1 KLINE
      CHARACTER*19 ADLR
      DIMENSION KLINE(132)
      DIMENSION Q(300),S(300)
      DIMENSION ADLR(300)
C
      NWEIR=1
      OPEN(1,FILE='SIDEHYD.OU1',ERR=5,STATUS='OLD')
      NWEIR=2
      CLOSE(1)
5     CONTINUE
      IF(NWEIR.EQ.1)GO TO 20
C
C     READ THE CNTRL1 CONTROL FILE
C
      OPEN(4,FILE='CNTRL1.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
```

```
10    FORMAT(A50)
12    FORMAT(19A1)
C
      CLOSE(4)
      READ(L8,40)IUPSTA1
C
C     READ THE CNTRL2.DAT CONTROL FILE
C
      OPEN(4,FILE='CNTRL2.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
C
      CLOSE(4)
      READ(L8,40)IUPSTA2
C
20    CONTINUE
C
C     READ THE CONTROL FILE
C
      OPEN(4,FILE='CNTRL.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
C
      CLOSE(4)
C
C     GET THE FLOW THRESHOLD
C
      READ(L9,30)QTHR
30    FORMAT(15X,F15.0)
C
C     GET THE ITIME
```

```
C
      READ(L10,31)ITIME0
31    FORMAT(15X,I3)
C
C     GET THE NUMBER OF THE UPWEIR GAGE
C
      READ(L8,40)IUPSTA
40    FORMAT(15X,I15)
      ITIME=-9999
C
C     OPEN THE MOH2DF0.OUT FILE AND THE FILE OF HEC1 HYDROGRAPHS
C
      OPEN(1,FILE='MOH2DF0.OUT')
      OPEN(2,FILE='RETRHYD.OUT')
C
C     OPEN THE OUTPUT FILE FOR THIS PROGRAM
C
      OPEN(3,FILE='MOH2DF1.OUT')
C
CJFB  WRITE(*,50)
50    FORMAT(1X,  '******************************',/,
     .       1X,  '* PROGRAM MOH2DF1.FOR        *',/,
     .       1X,  '* MODIFY HEC2 QT CARDS       *',/,
     .       1X,  '* VERSION 12/26/95           *',/,
     .       1X,  '******************************',/)
C
      CALL GETDAT(IYR,IMO,IDA)
      CALL GETTIM(IHR,IMI,ISE,I100TH)
      WRITE(*,51)IMO,IDA,IYR,IHR,IMI,ISE,NWEIR
51    FORMAT(2H* ,'MOH2DF1.FOR     ',I2.2,'/',I2.2,'/',I4.4,
     .              2X,I2.2,':',I2.2,':',I2.2,5X,I2)
C
100   CONTINUE
C
101   CONTINUE
C
C     SKIP A LINE IN THE LIST OF HYDROGRAPHS
C
      READ(2,110)KLINE(1)
110   FORMAT(A1)
C
120   CONTINUE
C
C     SEARCH FOR THE UPWEIR STATION NUMBER (HYDROGRAPH)
C
      READ(2,130,END=190)NSTA
130   FORMAT(17X,I6)
      IF(NSTA.EQ.IUPSTA)GO TO 150
C
C     DONT FIND IT SKIP 300 LINES
C
      DO 140 I=1,300
      READ(2,110)KLINE(1)
140   CONTINUE
C
C     GO BACK AND TRY AGAIN
C
```

```
      GO TO 120
C
150   CONTINUE
C
C     PRINT TO SCREEN THE SUCCESS IN FINDING THE UPWEIR STATION
C
      WRITE(*,151)IUPSTA
151   FORMAT('  UPWEIR STA: ',I10)
C
C     READ IN THE DATA PERTAINING TO THE UPWEIR STATION
C
      DO 164 I=1,300
      READ(2,163) ADLR(I),Q(I)
163   FORMAT(1X,A19,F15.2)
164   CONTINUE
C
C     FIND THE 1ST TIME THE FLOW IS GT THE THRESHHOLD
C
      DO 165 I=1,300
      ITIME=I
      IF(Q(I).GT.QTHR)GO TO 170
165   CONTINUE
170   CONTINUE
C
C     FIND THE LAST TIME THE FLOW IS GT THE THRESHHOLD
C
      DO 175 I=1,300
      K=301-I
      JTIME=K
      IF(Q(K).GT.QTHR)GO TO 180
175   CONTINUE
180   CONTINUE
190   CONTINUE
      IF(ITIME.EQ.-9999)WRITE(*,191)
      IF(JTIME.EQ.-9999)WRITE(*,191)
191   FORMAT(1X,'ERROR 191: NO HYDROGRAPH AT UPWEIR')
      IF(ITIME.EQ.-9999)GO TO 900
      IF(JTIME.EQ.-9999)GO TO 900
C
C
      OPEN(4,FILE='C:\H1H2SH\RERNTOL.DAT')
      READ(4,194)RERNTOL
194   FORMAT(8X,F10.0)
      READ(4,195)INCHORD
195   FORMAT(8X,I10)
      CLOSE(4)
196   CONTINUE
      IF(MOD(ITIME,INCHORD).NE.MOD(JTIME,INCHORD))THEN
         JTIME=JTIME+1
         GO TO 196
         ENDIF
C
      IF(ITIME.LE.0)GO TO 197
      IF(ITIME.GT.300)GO TO 197
      IF(JTIME.LE.0)GO TO 197
      IF(JTIME.GT.300)GO TO 197
      GO TO 199
```

```
C
197   CONTINUE
      WRITE(*,198)ITIME,JTIME
198   FORMAT(1X,'ERROR 198  ITIME JTIME ',2I10)
      GO TO 900
C
199   CONTINUE
C
C     REWIND THE LIST OF HYDROGRAPHS
C
      REWIND(2)
C
C     READ LINES IN THE HEC2 BASE DATA FILE
C
200   CONTINUE
      READ(1,210,END=900)ILINE
210   FORMAT(A132)
C
C     IGNORE ALL QT CARDS IN THE BASE DATA FILE
C
      IF(INDEX(ILINE,'QT').EQ.1)GO TO 200
C
C     PROCESS J3 CARDS AT 250
C
      IF(INDEX(ILINE,'J3').EQ.1)GO TO 250
C
C     PROCESS X1 CARDS AT 300
C
      IF(INDEX(ILINE,'X1').EQ.1)GO TO 300
C
C     PROCESS ALL OTHER CARDS AT 500
C
      GO TO 500
C
C     REWRITE THE J3 CARD TO PRODUCE THE DESIRED SUMMARIES IN HEC2 OUTPUT
C
250   CONTINUE
      WRITE(3,260)
260   FORMAT('J3    38      43       1       8')
      GO TO 200
C
300   CONTINUE
C
C     REWIND THE LIST OF HYDROGRAPHS
C
      REWIND(2)
C
C     READ THE STATION NUMBER FROM THE BASE DATA FILE
C
      READ(ILINE,301)ISTA
301   FORMAT(2X,I6)
C     WRITE(*,301)ISTA
C
      IF(NWEIR.EQ.2)GO TO 310
C
      IF(ISTA.EQ.IUPSTA) THEN
         WRITE(3,303)ILINE
```

```
303      FORMAT(A132)
         READ(1,210,END=900)ILINE
         IF(INDEX(ILINE,'CI').EQ.1)WRITE(3,303)ILINE
         IF(ITIME0.EQ.0)GO TO 309
         OPEN(4,FILE='SIDEHYD.PLT')
         N=0
304      CONTINUE
         N=N+1
         READ(4,305,END=306)S(N)
305      FORMAT(26X,F9.0)
         GO TO 304
306      CONTINUE
         CLOSE(4)
         N=N-1
C
         J1=1
307      CONTINUE
         J2=J1+(9-1)
         IF(J2.GT.N)J2=N
         NJ=(J2-J1)+1
         WRITE(3,308)NJ,(S(I),I=J1,J2)
308      FORMAT('X5     ',I1,9F8.2)
C
         J1=J2+1
         IF(J1.LT.N)GO TO 307
C
309      CONTINUE
         IF(INDEX(ILINE,'CI').NE.1)WRITE(3,303)ILINE
         GO TO 200
      ENDIF
      GO TO 370
C
310   CONTINUE
C
      IF(ISTA.EQ.IUPSTA1) THEN
         WRITE(3,313)ILINE
313      FORMAT(A132)
         READ(1,210,END=900)ILINE
         IF(INDEX(ILINE,'CI').EQ.1)WRITE(3,313)ILINE
         IF(ITIME0.EQ.0)GO TO 319
         OPEN(4,FILE='SIDEHYD.PL1')
         N=0
314      CONTINUE
         N=N+1
         READ(4,315,END=316)S(N)
315      FORMAT(26X,F9.0)
         GO TO 314
316      CONTINUE
         CLOSE(4)
         N=N-1
C
         J1=1
317      CONTINUE
         J2=J1+(9-1)
         IF(J2.GT.N)J2=N
         NJ=(J2-J1)+1
         WRITE(3,318)NJ,(S(I),I=J1,J2)
```

```
318     FORMAT('X5     ',I1,9F8.2)
C
        J1=J2+1
        IF(J1.LT.N)GO TO 317
C
319     CONTINUE
        IF(INDEX(ILINE,'CI').NE.1)WRITE(3,303)ILINE
        GO TO 200
      ENDIF
C
      IF(ISTA.EQ.IUPSTA2) THEN
        WRITE(3,323)ILINE
323     FORMAT(A132)
        READ(1,210,END=900)ILINE
        IF(INDEX(ILINE,'CI').EQ.1)WRITE(3,303)ILINE
        IF(ITIME0.EQ.0)GO TO 329
        OPEN(4,FILE='SIDEHYD.PL2')
        N=0
324     CONTINUE
        N=N+1
        READ(4,325,END=326)S(N)
325     FORMAT(26X,F9.0)
        GO TO 324
326     CONTINUE
        CLOSE(4)
        N=N-1
C
        J1=1
327     CONTINUE
        J2=J1+(9-1)
        IF(J2.GT.N)J2=N
        NJ=(J2-J1)+1
        WRITE(3,328)NJ,(S(I),I=J1,J2)
328     FORMAT('X5     ',I1,9F8.2)
C
        J1=J2+1
        IF(J1.LT.N)GO TO 327
C
329     CONTINUE
        IF(INDEX(ILINE,'CI').NE.1)WRITE(3,303)ILINE
        GO TO 200
      ENDIF
C
C
370   CONTINUE
C
C     SKIP A LINE IN THE LIST OF HYDROGRAPHS
C
      READ(2,375)KLINE(1)
375   FORMAT(A1)
380   CONTINUE
C
C     READ THE STATION NUMBER IN THE LIST OF HYDROGRAPHS
C
      READ(2,382,END=390)NSTA
382   FORMAT(17X,I6)
C     WRITE(*,383)ISTA,NSTA
```

```
383   FORMAT(1X,'COMPARING :',2I8)
C
C     IF THE STATIONS NUMBERS AGREE   PROCESS AT 400
C
      IF(NSTA.EQ.ISTA)GO TO 400
C
C     OTHERWISE  SKIP 300 LINES IN THE HYDROGRAPH FILE AND TRY AGAIN
C
      DO 389 I=1,300
      READ(2,388)KLINE(1)
388   FORMAT(A1)
389   CONTINUE
      GO TO 380
C
390   CONTINUE
C
C     THIS STATION IS NOT IN THE HYDROGRAPH LIST.  PROCESS AT 500
C
      GO TO 500
C
400   CONTINUE
C
C     RETRIEVE HYDROGRAPH FROM THE LIST
C
      DO 435 I=1,300
      READ(2,430)         Q(I)
430   FORMAT(1X,19X,F15.0)
435   CONTINUE
C
C
C     DISPLAY MESSAGE TO SCREEN
C
      WRITE(*,480)ISTA,ITIME,JTIME
480   FORMAT('  QT STATION: ',3I10)
C
C     COMPOSE A NEW SET OF QT CARDS AND WRITE THEM TO OUTPUT
C
      J1=ITIME
481   CONTINUE
      J2=J1+(9-1)*INCHORD
      IF(J2.GE.JTIME)J2=JTIME
      NJ=((J2-J1)/INCHORD)+1
      WRITE(3,485)NJ,(Q(I),I=J1,J2,INCHORD)
485   FORMAT('QT     ',I1,9F8.0)
C
      J1=J2+INCHORD
      IF(J1.LE.JTIME)GO TO 481
C
C     PROCESS THE X1 CARD ITSELF AT 500
C
      GO TO 500
C
500   CONTINUE
C
C     WRITE THE CARD TO OUTPUT
C
      WRITE(3,510)ILINE
```

```
510   FORMAT(A132)
C
C     RETURN TO TOP
C
      GO TO 200
C
900   CONTINUE
C
C     CLOSE ALL FILES
C
      CLOSE(1)
      CLOSE(2)
      CLOSE(3)
C
C     REWRITE CONTROL FILE WITH NEW TIME DATE ITIME & JTIME INFORMATION
C
      OPEN(4,FILE='CNTRL.DAT')
      WRITE(4,901)
901   FORMAT('PROCESSED BY  :MOH2DF1.FOR')
      WRITE(4,902)IHR,IMI,ISE
902   FORMAT('TIME          :',I2.2,':',I2.2,':',I2.2)
      WRITE(4,903)IMO,IDA,IYR
903   FORMAT('DATE          :',I2.2,'-',I2.2,'-',I4.4)
      WRITE(4,904)L4
904   FORMAT(A50)
      WRITE(4,905)L5
905   FORMAT(A50)
      WRITE(4,906)L6
906   FORMAT(A50)
      WRITE(4,907)L7
907   FORMAT(A50)
      WRITE(4,908)L8
908   FORMAT(A50)
      WRITE(4,909)L9
909   FORMAT(A50)
      READ(ADLR(ITIME),12)(KLINE(I),I=1,19)
      WRITE(4,910)ITIME,(KLINE(I),I=4,14)
910   FORMAT('ITIME         :',I3.3,1X,14A1)
      READ(ADLR(JTIME),12)(KLINE(I),I=1,19)
      WRITE(4,911)JTIME,(KLINE(I),I=4,14)
911   FORMAT('JTIME         :',I3.3,1X,14A1)
      WRITE(4,912)L12
912   FORMAT(A50)
      WRITE(4,913)L13
913   FORMAT(A50)
      WRITE(4,914)L14
914   FORMAT(A50)
      WRITE(4,915)L15
915   FORMAT(A50)
      CLOSE(4)
C
1000  CONTINUE
      END
```

6.1.6 - MOH2DF2.FOR

MOH2DF2.FOR is a third Fortran program for manipulation of the HEC-2 input files.

```
C     PROGRAM MOH2DF2.FOR
C
C     PURPOSE         : TO CREATE THE SET OF HEC2 INPUT FILES
C     INVOKED BY      : SCRIPT1.BAT (THE FIRST TIME) AND SCRIPT3.BAT
C     INPUT REQUIRED  : CNTRL.DAT MOH2DF1.OUT
C     OUTPUT PRODUCED : CNTRL.DAT MOH2DF2.D01...MOH2DF2.Dnn
C
C
C
      CHARACTER*70 L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14,L15
      CHARACTER*35 JFILE
      CHARACTER*80 ILINE,T1,T2,T3,J1,J2
      CHARACTER*1 KLINE
      DIMENSION KLINE(80)
C     DIMENSION Q(300)
C
C
      OPEN(4,FILE='CNTRL.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
10    FORMAT(A50)
C
C     ADD 1 TO THE ITERATION COUNT
C
      READ(L15,12)IL15
12    FORMAT(15X,I3)
      IL15=IL15+1
C
      CLOSE(4)
C
C
      OPEN(1,FILE='MOH2DF1.OUT')
      IFREE=0
C
CJFB  WRITE(*,20)
20    FORMAT(1X,  '******************************',/,
     .       1X,  '* PROGRAM MOH2DF2.FOR        *',/,
     .       1X,  '* MODIFY HEC2 QT CARDS       *',/,
     .       1X,  '* VERSION 12/06/95           *',/,
```

```
     .       1X,  '*****************************',/)
C
      CALL GETDAT(IYR,IMO,IDA)
C     IYR=IYR-1900
      CALL GETTIM(IHR,IMI,ISE,I100TH)
      WRITE(*,30)IMO,IDA,IYR,IHR,IMI,ISE
30    FORMAT(2H* ,'MOH2DF2.FOR     ',I2.2,'/',I2.2,'/',I4.4,
     .              2X,I2.2,':',I2.2,':',I2.2,)
C

C
100   CONTINUE
C
C     READ THE TITLE AND JOB CARDS
C
      READ(1,109)T1
      IF(INDEX(T1,'FR').EQ.1)IFREE=1
      IF(INDEX(T1,'T1').EQ.1)GO TO 101
      GO TO 100
101   CONTINUE
      READ(1,109)T2
      IF(INDEX(T2,'T2').EQ.1)GO TO 102
      GO TO 101
102   CONTINUE
      READ(1,109)T3
      IF(INDEX(T3,'T3').EQ.1)GO TO 103
      GO TO 102
103   CONTINUE
      READ(1,109)J1
      IF(INDEX(J1,'J1').EQ.1)GO TO 104
      GO TO 103
104   CONTINUE
      READ(1,109)J2
      IF(INDEX(J2,'J2').EQ.1)GO TO 105
      GO TO 104
105   CONTINUE
109   FORMAT(A80)
C
C
C     FIND THE FIRST QT CARD AND GO TO 200
C
110   CONTINUE
      READ(1,120,END=900)ILINE
120   FORMAT(A80)
C
      IF(INDEX(ILINE,'QT').EQ.1)GO TO 200
      GO TO 110
C
C     MAKE A COUNT OF HOW MANY QT CARDS OCCUR IN SEQUENCE
C
200   CONTINUE
      NQT=1
210   CONTINUE
      READ(1,120,END=900)ILINE
      IF(INDEX(ILINE,'QT').NE.1)GO TO 300
      NQT=NQT+1
      GO TO 210
```

```
C
C     GO THROUGH THE MAIN LOOP THAT MANY TIMES
C
300   CONTINUE
      DO 600 ITH=1,NQT
C
C     CREATE A NEW OUTPUT FILE AND NAME IT APPROPRIATELY
C
      WRITE(JFILE,305)ITH
305   FORMAT('MOH2DF2.D',I2.2)
      OPEN(2,FILE=JFILE)
      WRITE(*,306)JFILE
306   FORMAT(2X,'CREATED FILE: ',A11)
C
C     REWIND THE INPUT FILE
C
      REWIND(1)

310   CONTINUE
C
C     READ A LINE FROM INPUT
C
      READ(1,120)ILINE
C
C     IF IT IS A QT OR AN X5 CARD GO TO 400 TO PROCESS IT
C
      IF(INDEX(ILINE,'QT').EQ.1)GO TO 400
      IF(INDEX(ILINE,'X5').EQ.1)GO TO 400
C
C     IF IT IS AN EJ CARD GO TO 500 TO PROCESS IT
C
      IF(INDEX(ILINE,'EJ').EQ.1)GO TO 500
C
C     OTHERWISE COPY IT AND GO TO 310
C
      WRITE(2,120)ILINE
      GO TO 310
C
400   CONTINUE
C
C     SKIP IF NECESSARY TO THE APPROPRIATE QT OR X5 CARD IN THE SET
C
      IF(ITH.EQ.1)GO TO 450
      DO 410 J=1,ITH-1
      READ(1,120)ILINE
410   CONTINUE
450   CONTINUE
C
C     READ THE NUMBER OF FLOWS FIELD
C
      READ(ILINE,452)NQ
452   FORMAT(2X,I6)
C
C     WRITE THE LINE TO OUTPUT
C
      WRITE(2,120)ILINE
C
```

```
C     IF THIS IS NOT THE LAST QT CARD  SKIP THE REST
C
      IF(ITH.EQ.NQT)GO TO 490
      DO 480 J=ITH+1,NQT
      READ(1,120)ILINE
480   CONTINUE
490   CONTINUE
C
C     GO TO 310 AND READ THE NEXT LINE
C
      GO TO 310
C
C     SET UP THE MULTIPLE PROFILE JOB CONTROL STACK
C
500   CONTINUE
      WRITE(2,120)ILINE
      IF(IFREE.EQ.1)WRITE(2,501)
501   FORMAT('*FIXED')
C
      DO 595 II=1,NQ-1
      IIP1=II+1
      IIP2=II+2
      WRITE(2,120)T1
      WRITE(2,120)T2
      WRITE(2,120)T3
C
      IF(INDEX(J1,',').EQ.0)GO TO 540
      J=3
      L=1
520   CONTINUE
      L=L+8
      IF(L.GT.81)GO TO 540
      K=INDEX(J1,',')
      IF(K.EQ.0)K=LEN_TRIM(J1)+1
      READ(J1,521)(KLINE(I),I=1,80)
521   FORMAT(80A1)
      DO 530 I=1,80-J
      M=81-I
      N=M-(L-K)
      IF(N.LT.J)N=3
      KLINE(M)=KLINE(N)
530   CONTINUE
      KLINE(L)=" "
      WRITE(J1,521)(KLINE(I),I=1,80)
      J=L
      GO TO 520
C
540   CONTINUE
      READ(J1,541)(KLINE(K),K=1,80)
541   FORMAT(80A1)
      WRITE(J1,542)(KLINE(K1),K1=1,8),IIP2,(KLINE(K2),K2=17,80)
542   FORMAT(8A1,I8,64A1)
      WRITE(2,120)J1
C
550   CONTINUE
      IF(INDEX(J2,',').EQ.0)GO TO 590
      J=3
```

```
      L=1
570   CONTINUE
      L=L+8
      IF(L.GT.81)GO TO 590
      K=INDEX(J2,',')
      IF(K.EQ.0)K=LEN_TRIM(J2)+1
      READ(J2,571)(KLINE(I),I=1,80)
571   FORMAT(80A1)
      DO 580 I=1,80-J
      M=81-I
      N=M-(L-K)
      IF(N.LT.J)N=3
      KLINE(M)=KLINE(N)
580   CONTINUE
      KLINE(L)=" "
      WRITE(J2,521)(KLINE(I),I=1,80)
      J=L
      GO TO 570
C
590   CONTINUE
      READ(J2,591)(KLINE(K),K=1,80)
591   FORMAT(80A1)
      WRITE(J2,593)(KLINE(K1),K1=1,2),IIP1,(KLINE(K2),K2=9,80)
593   FORMAT(2A1,I6,72A1)
      WRITE(2,120)J2
C
595   CONTINUE
      WRITE(2,596)
596   FORMAT(' ',/,' ',/,' ')
      WRITE(2,597)
597   FORMAT('ER')
C
C     CLOSE THE OUTPUT FILE
C
      CLOSE(2)
C
C     END OF THE MAJOR LOOP
C
600   CONTINUE
C
C     CLOSE THE INPUT FILE
C
900   CONTINUE
      CLOSE(1)
C
C     REWRITE THE CNTRL.DAT FILE WITH # OF HEC2 INPUT FILES & ITERATION COUNT
C
      OPEN(4,FILE='CNTRL.DAT')
      WRITE(4,901)
901   FORMAT('PROCESSED BY  :MOH2DF2.FOR')
      WRITE(4,902)IHR,IMI,ISE
902   FORMAT('TIME          :',I2.2,':',I2.2,':',I2.2)
      WRITE(4,903)IMO,IDA,IYR
903   FORMAT('DATE          :',I2.2,'-',I2.2,'-',I4.4)
      WRITE(4,904)L4
904   FORMAT(A50)
      WRITE(4,905)L5
```

```
905   FORMAT(A50)
      WRITE(4,906)L6
906   FORMAT(A50)
      WRITE(4,907)L7
907   FORMAT(A50)
      WRITE(4,908)L8
908   FORMAT(A50)
      WRITE(4,909)L9
909   FORMAT(A50)
      WRITE(4,910)L10
910   FORMAT(A50)
      WRITE(4,911)L11
911   FORMAT(A50)
      WRITE(4,912)NQT
912   FORMAT('NH2FILES      :',I5.5)
      WRITE(4,913)L13
913   FORMAT(A50)
      WRITE(4,914)L14
914   FORMAT(A50)
      WRITE(4,915)IL15
915   FORMAT('ITERATION     :',I3.3)
      CLOSE(4)
C
      END
```

6.1.7 - CNTRL.FOR

CNTRL.FOR is a Fortran control program to create the SCRIPT2.BAT file.

```
C     PROGRAM CNTRL.FOR
C
C     PURPOSE         : TO CREATE THE SCRIPT2.BAT FILE
C     INVOKED BY      : SCRIPT1.BAT (THE FIRST TIME) AND SCRIPT3.BAT
C     INPUT REQUIRED  : CNTRL.DAT
C     OUTPUT PRODUCED : SCRIPT2.BAT
C
C
      CHARACTER*70 L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14,L15
C
C     OPEN AND READ THE CNTRL.DAT FILE
C
      OPEN(4,FILE='CNTRL.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
10    FORMAT(A50)
C
      CLOSE(4)
C
C     GET THE NUMBER OF QT CARDS (NUMBER OF HEC2.Dnn) FILES
C
      READ(L12,20)NQT
20    FORMAT(15X,I5)
C
CJFB  WRITE(*,50)
50    FORMAT(1X,  '*******************************',/,
     .       1X,  '* PROGRAM CNTRL.FOR            *',/,
     .       1X,  '* CREATE SCRIPT2.BAT           *',/,
     .       1X,  '* VERSION 12/15/95             *',/,
     .       1X,  '*******************************',/)
C
      CALL GETDAT(IYR,IMO,IDA)
      CALL GETTIM(IHR,IMI,ISE,I100TH)
      WRITE(*,51)IMO,IDA,IYR,IHR,IMI,ISE
51    FORMAT(2H* ,'CNTRL.FOR       ',I2.2,'/',I2.2,'/',I4.4,
     .              2X,I2.2,':',I2.2,':',I2.2,)
C
100   CONTINUE
C
```

```
C     OPEN AND WRITE THE SCRIPT2.BAT FILE
C
      OPEN(1,FILE='SCRIPT2.BAT')
C
      DO 190 I=1,NQT
      WRITE(1,110)I,I,I
110   FORMAT('HEC2 INPUT=MOH2DF2.D',I2.2,' OUTPUT=D',I2.2,
     .       ' TAPE95=TAPE95 >H2CON.D',I2.2)

      WRITE(1,120)
120   FORMAT('@DEL TAPE*.*')
190   CONTINUE
C
C     WRITE THE SCRIPT2.BAT FILE
C
      WRITE(1,210)
210   FORMAT('C:\H1H2SH\MOH2OF.EXE')
      WRITE(1,220)
220   FORMAT('C:\H1H2SH\MOSWDF.EXE')
      WRITE(1,230)
230   FORMAT('C:\H1H2SH\SIDEHYD.EXE INPUT=MOSWDF.OUT')
      WRITE(1,235)
235   FORMAT('C:\H1H2SH\MOH1DF.EXE')
      WRITE(1,240)
240   FORMAT('C:\H1H2SH\GP2.EXE')
      WRITE(1,250)
250   FORMAT('SCRIPT3.BAT')
      CLOSE(1)
      END
```

6.1.8 - KCNTRL.FOR

KCNTRL.FOR is a Fortran control program to create the SCRIPT2.BAT file for a two-weir analysis.

```
C     PROGRAM KCNTRL.FOR
C
C     PURPOSE         : TO CREATE THE SCRIPT2.BAT FILE
C     INVOKED BY      : SCRIPT1.BAT THE FIRST TIME AND SCRIPT3.BAT THEREAFTER
C     INPUT REQUIRED  : CNTRL1.DAT  CNTRL2.DAT
C     OUTPUT PRODUCED : SCRIPT2.BAT
C
      CHARACTER*70 L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14,L15
C
C     OPEN AND READ THE CNTRL1.DAT FILE
C
      OPEN(4,FILE='CNTRL1.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
10    FORMAT(A50)
C
      CLOSE(4)
C
C     OPEN AND READ THE CNTRL2.DAT FILE
C
      OPEN(4,FILE='CNTRL2.DAT')
      READ(4,10)L7
      READ(4,10)L7
      READ(4,10)L7
      READ(4,10)L7
      READ(4,10)L7
      READ(4,10)L7
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L13
      READ(4,10)L13
      READ(4,10)L13
      READ(4,10)L13
      READ(4,10)L13
      READ(4,10)L14
C
      REWIND(4)
```

```
C
C     REWRITE THE CNTRL2.BAT FILE WITH ITIME JTIME  INFORMATION

      WRITE(4,10)L1
      WRITE(4,10)L2
      WRITE(4,10)L3
      WRITE(4,10)L4
      WRITE(4,10)L5
      WRITE(4,10)L6
      WRITE(4,10)L7
      WRITE(4,10)L8
      WRITE(4,10)L9
      WRITE(4,10)L10
      WRITE(4,10)L11
      WRITE(4,10)L12
      WRITE(4,10)L13
      WRITE(4,10)L14
      WRITE(4,10)L15
C
      CLOSE(4)
C
C     GET THE NUMBER OF QT CARDS (NUMBER OF HEC2.Dnn) FILES
C
      READ(L12,20)NQT
20    FORMAT(15X,I5)
C
CJFB  WRITE(*,50)
50    FORMAT(1X,  '******************************',/,
     .       1X,  '* PROGRAM KCNTRL.FOR         *',/,
     .       1X,  '* CREATE SCRIPT2.BAT         *',/,
     .       1X,  '* VERSION 12/15/95           *',/,
     .       1X,  '******************************',/)
C
      CALL GETDAT(IYR,IMO,IDA)
      CALL GETTIM(IHR,IMI,ISE,I100TH)
      WRITE(*,51)IMO,IDA,IYR,IHR,IMI,ISE
51    FORMAT(2H* ,'KCNTRL.FOR      ',I2.2,'/',I2.2,'/',I4.4,
     .              2X,I2.2,':',I2.2,':',I2.2,)
C
100   CONTINUE
C
C     OPEN AND WRITE THE SCRIPT2.BAT FILE
C
      OPEN(1,FILE='SCRIPT2.BAT')
C
      DO 190 I=1,NQT
      WRITE(1,110)I,I,I
110   FORMAT('HEC2 INPUT=MOH2DF2.D',I2.2,' OUTPUT=D',I2.2,
     .       ' TAPE95=TAPE95 >H2CON.D',I2.2)
      WRITE(1,120)
120   FORMAT('@DEL TAPE*.*')
C
190   CONTINUE
C
C     WRITE THE SCRIPT2.BAT FILE
C
      WRITE(1,200)
```

```
200   FORMAT('@COPY CNTRL1.DAT CNTRL.DAT')
C
      WRITE(1,300)
300   FORMAT('C:\H1H2SH\MOH2OF.EXE')
      WRITE(1,310)
310   FORMAT('C:\H1H2SH\MOSWDF.EXE')
      WRITE(1,320)
320   FORMAT('C:\H1H2SH\SIDEHYD.EXE INPUT=MOSWDF.OUT')
      WRITE(1,330)
330   FORMAT('C:\H1H2SH\MOH1DF.EXE')
      WRITE(1,345)
345   FORMAT('@COPY CNTRL.DAT CNTRL1.DAT')
      WRITE(1,350)
350   FORMAT('@COPY MOH1DF.OUT MOH1DF.OU1')
      WRITE(1,355)
355   FORMAT('@DEL MOH1DF.OUT')
      WRITE(1,360)
360   FORMAT('@COPY SIDEHYD.OUT SIDEHYD.OU1')
      WRITE(1,365)
365   FORMAT('@DEL SIDEHYD.OUT')
      WRITE(1,370)
370   FORMAT('@COPY SIDEHYD.PLT SIDEHYD.PL1')
      WRITE(1,375)
375   FORMAT('@DEL SIDEHYD.PLT')
      WRITE(1,380)
380   FORMAT('@COPY SIDEHYD.HST SIDEHYD.HS1')
      WRITE(1,385)
385   FORMAT('@DEL SIDEHYD.HST')
C
      WRITE(1,400)
400   FORMAT('@COPY CNTRL2.DAT CNTRL.DAT')
C
      WRITE(1,500)
500   FORMAT('C:\H1H2SH\MOH2OF.EXE')
      WRITE(1,510)
510   FORMAT('C:\H1H2SH\MOSWDF.EXE')
      WRITE(1,520)
520   FORMAT('C:\H1H2SH\SIDEHYD.EXE INPUT=MOSWDF.OUT')
      WRITE(1,530)
530   FORMAT('C:\H1H2SH\MOH1DF.EXE')
      WRITE(1,545)
545   FORMAT('@COPY CNTRL.DAT CNTRL2.DAT')
      WRITE(1,550)
550   FORMAT('@COPY MOH1DF.OUT MOH1DF.OU2')
      WRITE(1,555)
555   FORMAT('@DEL MOH1DF.OUT')
      WRITE(1,560)
560   FORMAT('@COPY SIDEHYD.OUT SIDEHYD.OU2')
      WRITE(1,565)
565   FORMAT('@DEL SIDEHYD.OUT')
      WRITE(1,570)
570   FORMAT('@COPY SIDEHYD.PLT SIDEHYD.PL2')
      WRITE(1,575)
575   FORMAT('@DEL SIDEHYD.PLT')
      WRITE(1,580)
580   FORMAT('@COPY SIDEHYD.HST SIDEHYD.HS2')
      WRITE(1,585)
```

```
585   FORMAT('@DEL SIDEHYD.HST')
C
      WRITE(1,600)
600   FORMAT('C:\H1H2SH\MO2H1DF.EXE')
      WRITE(1,610)
610   FORMAT('@COPY CNTRL1.DAT CNTRL.DAT')
      WRITE(1,620)
620   FORMAT('C:\H1H2SH\GP2.EXE')
C
      WRITE(1,810)
810   FORMAT('SCRIPT3.BAT')
C
      CLOSE(1)
      END
```

6.1.9 - MOH2OF.FOR

MOH2OF.FOR is a Fortran program for extracting HEC-2 output for the downstream end of the weir or weirs, for the two-weir case.

```
C     PROGRAM MOH2OF.FOR
C
C     PURPOSE         : TO COLLECT THE FLOWS AT THE DNWEIR STA
C     INVOKED BY      : SCRIPT2.BAT
C     INPUT REQUIRED  : CNTRL.DAT D01...Dnn
C     OUTPUT PRODUCED : MOH2OF.OUT
C
C
      CHARACTER*50 L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14,L15
      CHARACTER*35 JFILE
      CHARACTER*132 ILINE
C
C     OPEN AND READ THE CNTRL.DAT FILE
C
      OPEN(4,FILE='CNTRL.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
10    FORMAT(A50)
C
      CLOSE(4)
C
C     READ THE NUMBER OF Dnn FILES
C
      READ(L12,20)NQT
20    FORMAT(15X,I5)
C
C     READ THE DNWEIR STATION NUMBER
C
      READ(L13,21)IDNSTA
21    FORMAT(15X,I15)
C
CJFB  WRITE(*,50)
50    FORMAT(1X,  '******************************',/,
     .       1X,  '* PROGRAM MOH2OF.FOR         *',/,
     .       1X,  '* CREATE MOH2OF.OUT          *',/,
     .       1X,  '* VERSION 12/15/95           *',/,
     .       1X,  '******************************',/)
```

```
C
      CALL GETDAT(IYR,IMO,IDA)
      CALL GETTIM(IHR,IMI,ISE,I100TH)
C
C     OPEN THE OUTPUT FILE
C
      OPEN(2,FILE='MOH2OF.OUT')
C
      WRITE(*,51)IMO,IDA,IYR,IHR,IMI,ISE
51    FORMAT(2H* ,'MOH2OF.FOR      ',I2.2,'/',I2.2,'/',I4.4,
     .              2X,I2.2,':',I2.2,':',I2.2,)
C
100   CONTINUE
C
C     SET UP THE MAJOR LOOP
C
      DO 200 I=1,NQT
C
C     OPEN THE APPROPRIATE HEC2 OUTPUT FILE
C
      WRITE(JFILE,110)I
110   FORMAT('D',I2.2)
      OPEN(1,FILE=JFILE)
C
120   CONTINUE
C
C     READ A LINE...(IF END OF FILE GO TO 190)
C
      READ(1,130,END=190)ILINE
130   FORMAT(A132)
C
C     READ THE STATION NUMBER...(ON ANY ERROR GO TO 120)
C
      READ(ILINE,140,ERR=120)JSTA
140   FORMAT(1X,I8)
C
C     IF THE LINE REFERS TO THE DNWEIR STATION... WRITE IT TO OUTPUT
C
      IF(IDNSTA.EQ.JSTA)WRITE(2,130)ILINE
C
C     GO TO 120 AND TRY AGAIN
C
      GO TO 120
190   CONTINUE
C
C     CLOSE THE CURRENT INPUT FILE
C
      CLOSE(1)
C
C     END OF THE MAJOR LOOP
C
200   CONTINUE
C
900   CONTINUE
C
C     CLOSE THE OUTPUT FILE
C
```

```
CLOSE(2)
END
```

6.1.10 - MOSWDF.FOR

MOSWDF.FOR is a Fortran program for modifying the SIDEHYD input file using HEC-2 flow.

```
C     PROGRAM MOSWDF.FOR
C
C     PURPOSE         : TO MODIFY SIDEWEIR INPUT FILE USING THE HEC2 FLOWS
C     INVOKED BY      : SCRIPT2.BAT
C     INPUT REQUIRED  : CNTRL.DAT MOH2OF.OUT <SIDEHYD BASE DATA FILE>
C     OUTPUT PRODUCED : MOSWDF.OUT
C
C
      CHARACTER*50 L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14,L15
      CHARACTER*35 JFILE
      CHARACTER*132 ILINE
      CHARACTER*3 MDLR
C
C     READ THE CNTRL.DAT FILE
C
      OPEN(4,FILE='CNTRL.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
10    FORMAT(A50)
C
      CLOSE(4)
C
C     GET THE FILENAME OF THE SIDEWEIR BASE DATA FILE
C
      READ(L7,20)JFILE
20    FORMAT(15X,A35)
C
C     GET THE TIME STEP AND START TIME OF THE HEC1 FLOOD
C
      READ(L5,30)ITSTEP,ID0,MDLR,IY0,IH0,IM0
30    FORMAT(15X,I2,1X,I2,A3,I2,1X,I2,I2)
C
C     GET THE ITIME FOR FLOW ABOVE THRESHOLD
C
      READ(L10,40)ITIME
40    FORMAT(15X,I3)
C
```

```
CJFB  WRITE(*,50)
50    FORMAT(1X,  '******************************',/,
     .       1X,  '* PROGRAM MOSWDF.FOR         *',/,
     .       1X,  '* CREATE MOSWDF.OUT          *',/,
     .       1X,  '* VERSION 05/07/96           *',/,
     .       1X,  '******************************',/)
C
      CALL GETDAT(IYR,IMO,IDA)
      CALL GETTIM(IHR,IMI,ISE,I100TH)
      WRITE(*,51)IMO,IDA,IYR,IHR,IMI,ISE
51    FORMAT(2H* ,'MOSWDF.FOR      ',I2.2,'/',I2.2,'/',I4.4,
     .              2X,I2.2,':',I2.2,':',I2.2,)
C
      OPEN(4,FILE='C:\H1H2SH\RERNTOL.DAT')
      READ(4,52)RERNTOL
52    FORMAT(8X,F10.0)
      READ(4,55)INCHORD
55    FORMAT(8X,I10)
      CLOSE(4)
100   CONTINUE
C
C     OPEN THE BASE DATA FILE AND THE OUTPUT FILES
C
      OPEN(1,FILE=JFILE)
      OPEN(2,FILE='MOSWDF.OUT')
C
C     READ THE FIRST LINE FROM THE BASE DATA FILE
C
      READ(1,110)ILINE
110   FORMAT(A132)
C
C     COMPOSE A NEW FIRST LINE AND WRITE IT TO OUTPUT
C
      WRITE(2,105)
105   FORMAT(1H','SIDEHYD.OUT',1H',5X,1H','SIDEHYD.PLT',1H')
C
C     READ AND WRITE THE TITLE CARDS
C
      READ(1,*)NTITL
      WRITE(2,115)NTITL
115   FORMAT(I8)
      IF(NTITL.EQ.0)GO TO 130
C
      DO 120 I=1,NTITL
      READ(1,110)ILINE
      WRITE(2,110)ILINE
120   CONTINUE
C
C     READ AND WRITE THE NEXT THREE LINES OF THE BASE DATA FILE TO OUTPUT
C
130   CONTINUE
      DO 140 I=1,3
      READ(1,110)ILINE
      WRITE(2,110)ILINE
140   CONTINUE
C
C     READ TIME STEP DATA LINE. RECOMPUTE TPLT. WRITE TO OUTPUT.
```

```
C
      READ(1,*) NSTEP, NDSTEP, TCOMP, TPLT
      TPLT = FLOAT(INCHORD*ITSTEP)/60.
      WRITE(2,141) NSTEP, NDSTEP, TCOMP, TPLT
141   FORMAT(2I10,2F10.4)
C
C     READ AND WRITE THE POND GEOMETRY DATA
C
      READ(1,*)NPD
      WRITE(2,145)NPD
145   FORMAT(I8)
C
      DO 150 I=1,NPD
      READ(1,110)ILINE
      WRITE(2,110)ILINE
150   CONTINUE
C
C     OPEN THE HEC2 OUTPUT SUMMARY AND COUNT THE NUMBER OF LINES
C
      OPEN(3,FILE='MOH2OF.OUT')
      N=0
300   CONTINUE
      N=N+1
      READ(3,110,END=390)
      GO TO 300
390   CONTINUE
      N=N-1
400   CONTINUE
C
C     REWIND THE HEC2 OUTPUT SUMMARY
C
      REWIND(3)
500   CONTINUE
C
C     WRITE THE HEC2 OUTPUT SUMMARY TO OUTPUT
C
      WRITE(2,510)N
510   FORMAT(I8)
520   CONTINUE
C
C     COMPUTE THE ZERO TIME (DECIMAL) FOR FLOOD ABOVE THRESHOLD
C
      RTIM0=FLOAT(IH0)+FLOAT(IM0)/60.+FLOAT(ITIME-1)/(60./FLOAT(ITSTEP))
C
C     LOOP TO ADD THE HEC2 GENERATED HYDROGRAPH TO THE MOSWDF.OUT FILE
C
      DO 590 I=1,N
C
C     READ FLOW AND STAGE FROM MOH2OF.OUT
C
      READ(3,110)ILINE
      READ(ILINE,530)COL2,COL3
530   FORMAT(13X,F10.0,F10.0)
CJFB  RTIME=RTIM0+0.5*(I-1)
C
C     COMPUTE THE TIME ASSOCIATED WITH THE EVENT
C
```

```
      RTIME=RTIM0+(FLOAT(INCHORD*ITSTEP)/60.)*(I-1)
C
C     WRITE THE TIME STAGE AND FLOW TO MOSWDF.OUT
C
      WRITE(2,540)RTIME,COL3,COL2
540   FORMAT(3F10.2)
590   CONTINUE
C
C     CLOSE THE MOH2OF.OUT FILE
C
      CLOSE(3)
600   CONTINUE
C
C     READ AND SKIP THE HYDROGRAPH ORDINATES PROVIDED IN THE BASE DATA FILE
C
      READ(1,*)NHO
C
      DO 610 I=1,NHO
      READ(1,110)ILINE
610   CONTINUE
C
700   CONTINUE
C
C     READ AND WRITE THE LOW LEVEL OUTLET INFORMATION (IF ANY)
C
      READ(1,110,END=900)ILINE
      WRITE(2,110)ILINE
      GO TO 700
C
900   CONTINUE
C
C     CLOSE THE BASE DATA FILE AND OUTPUT FILES
C
      CLOSE(1)
      CLOSE(2)
      END
```

6.1.11 - SIDEHYD.FOR

SIDEHYD.FOR is a Fortran program for calculating side weir hydraulics and for tracking the filling and emptying of the detention basin. It also models the channel flow beside a side weir. This program is a modified version of the program previously called SIDEHYDR and reported in Davis and Holley (1988). It includes THYSYS and its subroutines as subroutines. Some of the subroutines of THYSYS have been modified to include the effects of flap gates and Tideflex valves. Specifically, the subroutines RC40 and RC47 not have equivalents RC40FLP and RC40FLX to account for flap gate and Tideflex valves on circular pipe culverts and RC47 has an equivalent RC47FLP to account for flap gates on box culverts.

```
C       PROGRAM SIDEHYD.FOR
C       06/07/98 VERSION
C
C       THIS PROGRAM USES A SPECIFIED WEIR LENGTH WITH D/S DISCHARGE AND
C       WATER SURFACE ELEVATION HYDROGRAPHS TO COMPUTE WEIR DISCHARGES, WATER
C       SURFACE ELEVATIONS IN THE BASIN, U/S DISCHARGES, AND U/S WATER
C       SURFACE ELEVATIONS.  WEIR SUBMERGENCE AND REVERSE FLOW OVER THE WEIR
C       ARE INCLUDED.  DIVERSION CULVERTS AND DRAINAGE CULVERTS ARE ALSO INCLUDED.
C
      CHARACTER*80 ADLR
      CHARACTER*20 CDLR
      REAL    MANN,MANN2
      INTEGER*2 ISTAT,IHR,IMIN,ISEC,I100S,IYR,IMONTH,IDAY
      LOGICAL QCRIT
      CHARACTER*1 BDLR
      CHARACTER*4 AGATE
      CHARACTER*78 TITLE
      CHARACTER*40 INFIL,OUTFIL,PLTFIL

     DIMENSION Q(0:102), Y(0:102), XLEN(0:102), QLL(0:9502),
    &QUR(0:9502),YUR(0:9502),QDR(0:9502),QDSTR(0:102),YDR(0:9502),
    &YDSTR(0:102),TSTR(0:102),TR(0:9502),QWR(0:9502),VPD(0:102),
    &APD(0:102),YPD(0:102),PDVOL(0:9502),PDY(0:9502),
    &KGATE(10),RWSTA(10),CDIA(10),CHFA(10),CWFA(10),CLFA(10),CIFA(10),
    &COFA(10),QSOA(10),HSOA(10),TSOA(10),VSOA(10),TWVMA(10),TWXPA(10),
    &TWVPA(10)
C
      EQUIVALENCE (PONDY,YBAS1), (B,CWIDTH)
C
      COMMON /BB/ QCRIT
      COMMON /CC/ CWIDTH,SS,SZ,WRP,P,PONDY,BETA,MANN,WRES,WRW,G,WRLEN
      COMMON /LEEDATA/ WIDBBLS,WIDTOT,CLMANN,ANBBL
      COMMON /CULVERT/ CLYUMAX,CLYUMIN,CLQMAX,CLQMIN,CLHWX,CLHWC

C
      G=32.17
C
```

```
C-----------------------------------------------------------------------
C
C  READ AND SET UP FILE NAMES, TITLES, DATE, TIME
C
       OPEN(0, FILE='CON', STATUS='UNKNOWN', BLANK = 'NULL')
C
C
       CALL GETARG(1,INFIL,ISTAT)
       IF(ISTAT.LE.6)INFIL='INPUT=SIDEHYD.DAT'
       WRITE(OUTFIL,1)INFIL
1      FORMAT(A40)
       READ(OUTFIL,2)INFIL
2      FORMAT(6X,A40)
C
       OPEN(5,FILE=INFIL,STATUS='OLD',BLANK='NULL')
6      CONTINUE
C
       READ(5,*)OUTFIL,PLTFIL
C
  15   CONTINUE
C
       OPEN(6,FILE=OUTFIL)
C
       CALL GETTIM(IHR,IMIN,ISEC,I100S)
       CALL GETDAT(IYR,IMONTH,IDAY)
       WRITE(0,16)IMONTH,IDAY,IYR,IHR,IMIN,ISEC
16     FORMAT(1X,'SIDEHYD.FOR      ',I2.2,'/',I2.2,'/',I4.4,
     .             2X,I2.2,':',I2.2,':',I2.2)
       WRITE(6,19)IMONTH,IDAY,IYR,IHR,IMIN
C
       WRITE(6,100)
C
       READ(5,*)NTITL
       IF(NTITL .EQ. 0) GOTO 18
       DO 17 ITITL = 1,NTITL
         READ(5,*)TITLE
         WRITE(6,3)TITLE
  17   CONTINUE
C
  18   CONTINUE
C
C
C-----------------------------------------------------------------------
C
C  READ INPUTS AND ECHO THEM TO OUTPUT FILE.
C
       READ(5,*) IMON
       READ(5,*) CWIDTH, SS, SZ, ZD, MANN
       READ(5,21)ADLR
21     FORMAT(A80)
       IF(INDEX(ADLR,"CULV").GT.0)THEN
          IWEIR=0
          CALL JSTR(ADLR,CDLR)
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)CLP
          WRP=CLP
        CLENDEL=ZD+CLP
```

```
22        FORMAT(F20.0)
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)ANBBL
         NBBL=INT(ANBBL+0.5)
          IF(NBBL.GT.3)THEN
             WRITE(*,155)
          ENDIF
        CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)CLH
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)CLW
         CALL JSTR(ADLR,CDLR)
         READ(CDLR,22)CLWT
         WIDTOT=ANBBL*CLW+(ANBBL-1.)*CLWT
         WIDBBLS=ANBBL*CLW
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)CLLEN
         CLXDS=0.
         CLXUS=CLXDS-CLLEN
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)CLMANN
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)CLAK
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)CLSLOPE
          GO TO 24
        ENDIF
        IF(INDEX(ADLR,"WEIR").GT.0)THEN
          IWEIR=1
          CALL JSTR(ADLR,CDLR)
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)WRP
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)WRLEN
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)WRW
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)WRES
          GO TO 24
        ENDIF
C       PROCESS ORIGINAL (UNSPECIFIED) FORMAT
          IWEIR=1
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)WRP
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)WRLEN
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)WRW
          CALL JSTR(ADLR,CDLR)
          READ(CDLR,22)WRES
24      CONTINUE
        READ(5,*) NSTEP, NDSTEP, TCOMP, TPLT
C
        IF(TPLT .LE. 0.0001)PLTFIL=' '
        WRITE(6,20)INFIL,OUTFIL,PLTFIL
C
        MANN2=(MANN/1.49)**2
```

```
      DZW=SZ*WRLEN
      ZU=ZD+DZW
      WRELD=WRP+ZD
      WRELU=WRP+ZU
C
      WRITE(6,115)CWIDTH,SS,SZ,ZD,MANN
      IF(SS .LT. 2.5)WRITE(6,114)
      IF(SS .GT. 4.0)WRITE(6,114)
      IF(IWEIR.EQ.1)WRITE(6,116)WRP,WRELD,WRELU,WRLEN,WRW,WRES
      IF(IWEIR.EQ.0)WRITE(6,117)CLP
      IF(IWEIR.EQ.0)WRITE(6,118)CLH,CLW
      IF(IWEIR.EQ.0)WRITE(6,119)CLWT
      IF(IWEIR.EQ.0)WRITE(6,120)CLLEN,NBBL,CLMANN,CLAK,CLSLOPE
      IF(IWEIR.EQ.0)THEN
         IF(NBBL.GT.3)THEN
        WRITE(6,155)
       ELSE
         WRITE(6,263)
       ENDIF
      ENDIF
C
      IF(IWEIR.EQ.0)WRP=CLP
C
      READ(5,*) NPD
      VPD(1)=0.
      DO 25 I=1,NPD
        READ(5,*) YPD(I), APD(I)
        IF (I .GT. 1)VPD(I)=VPD(I-1)+(YPD(I)-YPD(I-1))*
     &                      (APD(I)+APD(I-1)+SQRT(APD(I)*APD(I-1)))/3.
 25   CONTINUE
C
      READ(5,*)ND
C
      WRITE(6,121)
      IF(IWEIR.EQ.1)WRITE(6,122)NSTEP,NDSTEP
      WRITE(6,123)ND,TCOMP,TPLT
      WRITE(6,132)
C
C CONVERT FROM INPUT BASIN ELEVATION TO BASIN ELEVATION RELATIVE TO
C CHANNEL INVERT AT D/S END OF WEIR.
C
      YPD1=YPD(1)
      DO 26 I=1,NPD
        WRITE(6,133) YPD(I), APD(I), VPD(I)
        YPD(I)=YPD(I)-ZD
 26   CONTINUE
C
      WRITE(6,136)
      DO 27 I = 1,ND
        READ(5,*) TSTR(I),WSELD,QDSTR(I)
C
C CONVERT FROM D/S CHANNEL WATER SURFACE ELEVATION TO DEPTH RELATIVE TO
C D/S INVERT ELEVATION.
C
        YDSTR(I)=WSELD-ZD
        CALL AREA(YDSTR(I),A,T,R)
        CFN=QDSTR(I)*QDSTR(I)*T/((A**3)*G)
```

```
          WRITE(6,137) TSTR(I),WSELD,YDSTR(I),QDSTR(I)
  27   CONTINUE
C
C
       READ(5,*,END=39)NDRAINC
C
       IF(NDRAINC.EQ.0)GO TO 39
       IF(NDRAINC.GT.10)THEN
          WRITE(*,151)
          WRITE(6,151)
          GOTO 9998
          ENDIF
       WRITE(6,140)
       DO 31 I=1,NDRAINC
       READ(5,21)ADLR
       IF(INDEX(ADLR,"NONE").GT.0)KGATE(I)=0
       IF(INDEX(ADLR,"FLAP").GT.0)KGATE(I)=1
       IF(INDEX(ADLR,"FLEX").GT.0)KGATE(I)=2
       CALL JSTR(ADLR,CDLR)
       READ(CDLR,29)AGATE
29     FORMAT(A4)
       CALL JSTR(ADLR,CDLR)
       READ(CDLR,22)RWSTA(I)
       CALL JSTR(ADLR,CDLR)
       READ(CDLR,22)CDIA(I)
       CALL JSTR(ADLR,CDLR)
       READ(CDLR,22)CHFA(I)
       CALL JSTR(ADLR,CDLR)
       READ(CDLR,22)CWFA(I)
       CALL JSTR(ADLR,CDLR)
       READ(CDLR,22)CLFA(I)
       CALL JSTR(ADLR,CDLR)
       READ(CDLR,22)CIFA(I)
       CALL JSTR(ADLR,CDLR)
       READ(CDLR,22)COFA(I)
       WRITE(6,141)
     &  AGATE,RWSTA(I),CDIA(I),CHFA(I),CWFA(I),CLFA(I),CIFA(I),COFA(I)
       RWSTA(I)=-1.*RWSTA(I)
       IF(AGATE.EQ.'NONE')KGATE(I)=0
       IF(AGATE.EQ.'FLAP')KGATE(I)=1
       IF(AGATE.EQ.'FLEX')KGATE(I)=2
       IF(KGATE(I).EQ.2.AND.CDIA(I).EQ.0.)THEN
          WRITE(*,154)
          WRITE(6,154)
          GO TO 9998
          ENDIF
  31   CONTINUE
  39   CONTINUE
C
C----------------------------------------------------------------------
C
C----------------------------------------------------------------------
C
C  INITIALIZE VARIABLES.
C
       IMAX=NSTEP+2*NDSTEP+1
       IF(IMAX.GT.102)THEN
```

```
          WRITE(*,152)
          WRITE(6,152)
          GO TO 9998
          ENDIF
C
       DO 35 I= 1,IMAX
         Q(I) = 0.0
         Y(I) = 0.0
 35    CONTINUE
C
       TCOMPMN=TCOMP/1024.
       IQL=0
       IQW=0
       IEXT      = 0
       PDVOL(0)  = 0.0
       PDY(0)    = YPD(1)
       TR(0)     = TSTR(1) - TCOMP
       PONDY     = 0.
       QWR(0)    = 0.
C
C ----------------------------------------------------------------------
C ----------------------------------------------------------------------
C
C  THE D0 980 LOOP COMPUTES THE DESIRED INFORMATION (I.E. QU, QW,
C  YU, AND BASIN DATA) FOR EACH GIVEN D/S DISCHARGE AND DEPTH PAIR FOR
C  VARIOUS TIMES ALONG THE HYDROGRAPH.  THIS DO LOOP IS STEPPING THROUGH
C  TIME.
C
       WRITE(6,90)
       WRITE(6,91)
C                          THIS DO LOOP STRUCTURE                  980
C      DO 980 I = 1, NCOMP   REPLACED BY A 'GO TO 50' AFTER 980
C                          TO ALLOW VARIABLE TIME STEP SIZE
C
       ISTOP=0
       I=0
       TCOMPJ=TCOMP
C
     IF(IWEIR .EQ. 0) WRITE(*,52)
 50     CONTINUE
       DO 51 IL=1,NDRAINC
       QSOA(IL)= -99.
       HSOA(IL)= -99.
       TSOA(IL)= -99.
       VSOA(IL)= -99.
       TWXPA(IL)= -99.
       TWVPA(IL)= -99.
       TWVMA(IL)= -99.
51     CONTINUE
C
       TCOMPJ=TCOMP
       IF(IQL.GT.0.AND.IQW.EQ.0.AND.TCOMPJ.EQ.TCOMP)TCOMPJ=TCOMP*10.
       IF(ISTOP.EQ.1)GO TO 982
       I=I+1
       IF(I.GT.9502)THEN
          WRITE(*,153)
          WRITE(6,153)
```

```
          GO TO 982
          ENDIF
53      CONTINUE
        TR(I)=TR(I-1)+TCOMPJ
        IF(TR(I).GE.TSTR(ND))THEN
          ISTOP=1
          TR(I)=TSTR(ND)
        ENDIF
      IF(IWEIR .EQ. 0) WRITE(*,54) TR(I)
C
       ISTR=2
       IF(TR(I) .GT. TSTR(ISTR)) THEN
         DO 47 II=1,ND
         ISTR=II
         IF(TR(I) .LT. TSTR(ISTR))GOTO 48
47       CONTINUE
C
48       CONTINUE
C
       ENDIF
C
       RATIO=(TR(I)-TSTR(ISTR-1))/(TSTR(ISTR)-TSTR(ISTR-1))
       QDR(I)=QDSTR(ISTR-1)+RATIO*(QDSTR(ISTR)-QDSTR(ISTR-1))
       YDR(I)=YDSTR(ISTR-1)+RATIO*(YDSTR(ISTR)-YDSTR(ISTR-1))
C
C
C  INITIALIZE LOOP VARIABLES
C
        XLEN(1) = 0.0
        DX = -WRLEN/FLOAT(NSTEP)
        NSECT = 1
        P = WRP
        QCRIT = .FALSE.
        Q(1) = QDR(I)
        Y(1) = YDR(I)
        QD = QDR(I)
C
C ----------------------------------------------------------------------
C
C  DETERMINE WHETHER THERE IS FLOW IN EITHER DIRECTION OVER THE WEIR.
C
C                                                               GOTO 960
        IF(IWEIR.EQ.1)THEN
          IF ((Y(1) .GT. WRP) .OR. (PDY(I-1) .GT. WRP)) GOTO 960
        ENDIF
        IF(IWEIR.EQ.0)THEN
        IF ((Y(1) .GT. CLP) .OR. (PDY(I-1) .GT. CLP)) GOTO 960
        ENDIF
C
C ----------------------------------------------------------------------
C ----------------------------------------------------------------------
C
C  THIS SECTION IS FOR NO FLOW IN EITHER DIRECTION OVER THE WEIR.
C
C  CALCULATE THE WATER SURFACE PROFILE IN THE CHANNEL ALONG THE WEIR
C  (NOT THE END SLOPES).
C
```

```
      DO 865 J = 1, NSTEP
C
        CALL GVF(Q(1), Y(J), DX, Y(J+1))
        IF (QCRIT) THEN
           WRITE(6,93)I,J,TR(I),YDR(I),Y(J),QDR(I)
        ENDIF
        XLEN(J+1) = XLEN(J) + DX
 865  CONTINUE
C
      QU=QDR(I)
      YU=Y(NSTEP)
      QW=0.
      PDVOL(I)=PDVOL(I-1)
      PDY(I)=PDY(I-1)
C
C                                                              GOTO 990
      GOTO 990
C
C -----------------------------------------------------------------------
C -----------------------------------------------------------------------
C
C                                                                   960
 960  CONTINUE
C
C  DETERMINE DIRECTION OF FLOW. GO TO 73 FOR REVERSE FLOW.  TCOMP SHOULD
C  BE SMALL SINCE DIRECTION OF FLOW IS DETERMINED FROM PRESENT DEPTH IN
C  CHANNEL AND DEPTH IN BASIN FROM PREVIOUS TIME STEP.
C
C                                                               GOTO 73
      IF (PDY(I-1) .GE. Y(1)) GOTO 73
C
C -----------------------------------------------------------------------
C -----------------------------------------------------------------------
C
C  THIS SECTION IS FOR FORWARD FLOW FROM THE CHANNEL INTO THE BASIN.
C
C  IN GENERAL, CROSS SECTION D IS AT THE DOWNSTREAM END OF THE WEIR.
C  NOW, DISTINCTION NEEDS TO BE MADE BETWEEN THE ACTUAL DOWNSTREAM END
C  OF THE WEIR (CROSS SECTION AND SUFFIX DA) AND THE DOWNSTREAM END OF
C  THE FLOW EXPANSION ZONE (CROSS SECTION AND SUFFIX DB).  FOR VARIABLES
C  WHICH NEED TO BE EVALUATED AT ONLY THE ACTUAL DOWNSTREAM END OF THE
C  WEIR, JUST THE SUFFIX D IS USED RATHER THAN DA.
C
      YDB=Y(1)
      CALL AREA(YDB,ADB,T,R)
      VDB=QD/ADB
      VHEADB=VDB*VDB/(2*G)
C
C  CALCULATE CRITICAL DEPTH AT CROSS SECTION DB AS AN ESTIMATE OF THE
C  MINIMUM POSSIBLE SUBCRITICAL DEPTH AT DA.
C
      YCMAX=2*YDB
      YCMIN=0
      FLHS=QD*QD/G
      DO 772 IYC=1,25
        YC=.5*(YCMAX+YCMIN)
        CALL AREA(YC,A,T,R)
```

```
         RHS=A**3/T
         IF(ABS(FLHS/RHS-1) .LT. .001)GOTO 774
         IF(RHS .GT. FLHS)YCMAX=YC
         IF(RHS .LT. FLHS)YCMIN=YC
 772   CONTINUE
C
 774   CONTINUE
C
C  ITERATIONS ARE NEEDED TO DETERMINE THE DEPTH AT THE DOWNSTREAM END OF
C  THE WEIR (ACCOUNTING FOR THE FLOW EXPANSION) FROM THE DEPTH AT THE
C  DOWNSTREAM END OF THE EXPANSION ZONE, WHICH IS THE DEPTH OBTAINED
C  FROM THE HEC-2 CALCULATIONS.  THE ITERATIONS ARE DONE IN THE D0 QD
C  LOOP.  THE MOMENTUM EQUATION IS USED FOR EACH TRIAL WEIR DISCHARGE TO
C  DETERMINE THE DEPTH AT DOWNSTREAM END OF THE WEIR FOR FLOW EXPANSION
C  DOWNSTREAM OF THE END OF THE WEIR.
C
      IF (IWEIR .EQ. 1) THEN
        HEAD=YDB-WRP
        QWMIN=-(WRLEN+HEAD*WRES)*SQRT(G*HEAD**3)
      ENDIF
      IF (IWEIR .EQ. 0) THEN
        QWMIN=-WIDTOT*SQRT(G*(YDB-CLP)**3)
      ENDIF
        QWTOL=0.001
      IF(IWEIR .EQ. 0) QWTOL=0.005*(-QWMIN)/QD
      QWMAX=0.
        TQWMIN=999999.
        TQWMAX=-999999.
      BETADB=1.08 + 0.04*(SS-2.5)/(4.0-2.5)
C                                                                  DO 860
        DO 860 IQW=1,25
C
          QW1=0.5*(QWMAX+QWMIN)
          QU1=QD+ABS(QW1)
C
C  CALCULATE DEPTH AT CROSS SECTION DA FROM MOMENTUM EQUATION.
C
          BETA25=1.08
          BETA40=1.12
        IF(1.25.LE.QU1/QD)BETA25=0.991-0.301*(QU1/QD)+0.298*
     $                   (QU1/QD)**2.
          IF(1.2.LE.QU1/QD)BETA40=-0.073+0.987*(QU1/QD)
          BETA=BETA25 + (BETA40-BETA25)*(SS-2.5)/(4.0-2.5)
C
          YDAMAX=2*YDB
          YDAMIN=YC
          CALL AREA(YDB,ADB,T,R)
          RHS=YBAR(YDB,CWIDTH,SS,ADB)*ADB+BETADB*QD*QD/(G*ADB)
          DO 776 IYDA=1,50
             YDA=.5*(YDAMAX+YDAMIN)
             CALL AREA(YDA,ADA,T,R)
             FLHS=YBAR(YDA,CWIDTH,SS,ADA)*ADA+BETA*QD*QD/(G*ADA)
             IF((YDAMAX-YDAMIN) .LT..00001)GOTO 778
             IF(FLHS .GT. RHS)THEN
                YDAMAX=YDA
             ELSE
                YDAMIN=YDA
```

```
            ENDIF
 776      CONTINUE
C
 778      CONTINUE
          HD=YDA-WRP
          IF(HD.LE.0.) THEN
             QWMIN=QW1
             GOTO 859
          ENDIF
C
C  DURING EARLY STAGES OF RISING WATER LEVELS IN THE CHANNEL, THE FLOW
C  MAY BE OVER ONLY THE DOWNSTREAM (LOWER) PART OF THE SLOPING WEIR
C  CREST.  FOR THIS SITUATION, THE EFFECTIVE WEIR LENGTH FOR FORWARD
C  IS ESTIMATED BY PROJECTING THE DOWNSTREAM HEAD (HD) HORIZONTALLY IN
C  UPSTREAM DIRECTION UNTIL THE PROJECTION INTERSECTS THE SLOPING WEIR
C  CREST.
C
          EFFLEN=WRLEN
          IF(HD .LT. DZW)THEN
             EFFLEN=HD/SZ
             IF(EFFLEN .GT. WRLEN)EFFLEN=WRLEN
          ENDIF
C
C  CALCULATE BULK DISCHARGE COEFFICIENT FOR FLOW INTO BASIN.
C
          CALL AREA(YDA,ADA,T,R)
          VDA=QD/ADA
          FWD=VDA/(SQRT(G*HD))
C
C  CHECK FOR SUBMERGENCE EFFECTS ON DISCHARGE COEFFICIENT.  IF
C  SUBMERGENCE EXISTS, ITERATION IS NEEDED TO DETERMINE THE BASIN DEPTH
C  AT THE END OF THE TIME STEP.
C
          YBAS1=PDY(I-1)
C                                                                  DO 855
          DO 855 IYB=1,25
             CS=1.
C
             HT=YBAS1 - WRP
             SR=HT/HD
             IF (SR.GT.0.5) CS=1.-(2.*SR-1.)**4.85
             IF (CS.LT.0.)  CS=0.
C
C  CALCULATE THE WEIR OR CULVERT DISCHARGE.
C
             XL1=WRLEN+DZW*WRES
             XL2=XL1+2.*(HD-DZW)*WRES
             AW=0.5*DZW*XL1+0.5*(HD-DZW)*(XL1+XL2)
             IF(EFFLEN .LT. WRLEN)AW=0.5*HD*(EFFLEN+HD*WRES)
C
             IF(IWEIR.EQ.1)THEN
                TOL=0.001
                CALL CALCQW(QU,HT,HU,HD,QD,NSTEP,NDSTEP,IND)
                QW=-(QU-QD)
              YU=HU+P
             ENDIF
C
```

```
C
            IF(IWEIR.EQ.0)THEN
C
C CALCULATE UPSTREAM DEPTH FROM MOMENTUM EQUATION BASED ON ASSUMED QW.
C CROSS SECTION A IS IN THE CHANNEL AT THE DOWNSTREAM END OF THE
C DIVERSION CULVERTS.  CROSS SECTION U IS AT THE UPSTREAM END.
C
               QA=QD
               YA=YDA
               ISUBM=0
             IF((YDA-CLP) .GT. 1.2*CLH) ISUBM=1
               BETAA=BETA
               BETAU=BETADB
               CALL AREA(YA,AA,T,R)
               SFA  = FNSF(QA,AA,R)
               YBARA = YBAR(YA,CWIDTH,SS,AA)
            YUMAX=2.*YA
               CALL YCRIT(YUMAX,QD,YCR)
               YUMIN=YCR
C
               LFLG=0
               YUTOL=0.002
C
               DO 810 JYU=1,25
                 YU = 0.5*(YUMAX+YUMIN)
                 QU=QD-QW
                 CALL AREA(YU,AU,T,R)
                 SFU  = FNSF(QU,AU,R)
                 VBAR = 0.5*(QA/AA + QU/AU)
                 YBARU = YBAR(YU,CWIDTH,SS,AU)
                 FLHS = YBARU*AU+(BETAU*QU*QU)/(G*AU)
                 FRHS = YBARA*AA+(BETAA*QA*QA)/(G*AA)+VBAR*ABS(QW1)/G
     &                  + WIDTOT*(SFA*AA+SFU*AU)/2.
     &                  - WIDTOT*SZ*(AA+AU)/2.
C
                    IF((YUMAX-YUMIN) .LT. YUTOL .AND.
     &              ABS((FLHS-FRHS)/FLHS) .LT. 10.*YUTOL)GOTO 820
                 IF(FLHS .GT. FRHS)THEN
                    YUMAX=YU
                 ELSE
                    YUMIN=YU
                 ENDIF
 810           CONTINUE
               LFLG=1
               YU=YCR
C
 820           CONTINUE
C
C CALCULATE FORWARD FLOW THROUGH DIVERSION CULVERTS FOR TRIAL YU.
C
               CALL DIVCULV(CLAK,CLXUS,CLXDS,CLSLOPE,
     .                    CLENDEL,HT,FWD,YDA,ZU,YUC,QW,IERR)
C
          ENDIF
C
            QU=QD-QW
C
```

```
C  DETERMINE BASIN DEPTH FROM VOLUME OF WATER IN THE BASIN.
C
               DT       = (TR(I) - TR(I-1)) * 3600.
               PDVOL(I) = PDVOL(I-1) - 0.5*(QW+QWR(I-1))*DT/43560.
C
               DO 850 IP=2,NPD
                  IF (PDVOL(I) .GT. VPD(IP)) GOTO 850
                  YBAS2=(PDVOL(I)-VPD(IP-1))*(YPD(IP)-YPD(IP-1))/
     &                  (VPD(IP)-VPD(IP-1)) + YPD(IP-1)
                  GOTO 851
 850           CONTINUE
C
C  IF ACCUMULATED VOLUME IN BASIN EXCEEDS THE INPUT MAXIMUM
C  BASIN VOLUME, THEN EXTEND BASIN VERTICALLY UPWARD.
C
               YBAS2 = YPD(NPD) + (PDVOL(I)-VPD(NPD))/APD(NPD)
               IF(IEXT .EQ. 0) THEN
                  WRITE(6,138)
                  IEXT=1
               ENDIF
C                                                                  851
 851           CONTINUE
               TOL = 0.005
               CTOL=ABS(YBAS2-YBAS1)
               IF(CTOL .LT. TOL) GOTO 857
               YBAS1=YBAS2
C                                                                  855
 855        CONTINUE
            TCOMPJ=TCOMPJ/2.
            IF(TCOMPJ.LT.TCOMPMN)GO TO 856
            WRITE(6,259)TCOMPJ
            GO TO 53
 856        CONTINUE
            WRITE(6,257)CTOL,TOL
 857        CONTINUE
C
            PDY(I)=YBAS1
C
C  CHECK FOR CONVERGENCE OF ASSUMED AND CALCULATED WEIR FLOW.
C
            IF(QW1 .GT. QW) QWMAX=QW1
            IF(QW1 .LT. QW) QWMIN=QW1
            IF(ABS(QW1-QW)/QD .LT. QWTOL) GOTO 862
859         CONTINUE
C
            IF(QW.LT.TQWMIN)TQWMIN=QW
            IF(QW.GT.TQWMAX)TQWMAX=QW
C                                                                  860
860      CONTINUE
C
         IF(ABS(QW1-QW)/QD.LT. 0.01.AND.SR.GT.0.998.AND.SR.LT.1.000)
     &   GOTO 861

         IF(HD.LT.0.)GOTO 861
C
         WRITE(6,201)ABS(QW1-QW)/QD,TOL
C
```

```
861      CONTINUE
         QW=(TQWMAX+TQWMIN)/2.
C
862      CONTINUE
         IF(IND.EQ.-4)THEN
            WRITE(6,255)
         ENDIF
C
         IF(LFLG.EQ.1)THEN
            WRITE(6,256)CLYUMAX-CLYUMIN
            LFLG=0
         ENDIF
C
         IF(IERR.EQ.2) WRITE(6,264)CLQMAX-CLQMIN,HWX-HWC
C
         LFLG=0
C
         IF(ISUBM .EQ. 1) WRITE(6,270)YDA-P, 1.2*CLH
C
       GOTO 990
C
C  END OF SECTION FOR REVERSE FLOW FROM THE CHANNEL INTO THE BASIN.
C
C ----------------------------------------------------------------------
C
C                                                                    73
 73      CONTINUE
C
C  THIS SECTION IS FOR REVERSE FLOW FROM THE BASIN INTO THE CHANNEL.
C
C  COMPUTE DISCHARGE AND WATER SURFACE ELEVATION ALONG WEIR.  THE HEAD
C  ON THE WEIR COMES FROM THE BASIN DEPTH.  FOR EACH END SLOPE, NEGLECT
C  CHANGE IN INVERT ELEVATION ALONG END SLOPE.
C
C  ITERATE TO DETERMINE BASIN WATER SURFACE ELEVATION AT PRESENT TIME
C  (DO 870 LOOP).
C
       YBMAX=PDY(I-1)
       YBMIN=Y(1)
       IF(Y(1) .LT. WRP) YBMIN=WRP
C
C  DEFINE TRIAL QW FOR FIRST HC CALCULATION BY USING LINEAR
C  EXTRAPOLATION.
C
       QWRI1=QWR(I-1)
       QWRI2=QWR(I-2)
       IF(QWRI1 .LT. 0.)QWRI1=0.
       IF(QWRI2 .LT. 0.)QWRI2=0.
       DQWR=QWRI1-QWRI2
       QWHC=QWRI1+DQWR
       IF(QWHC .LT. 0.) QWHC=0.
       HCOLD=0.
       IF(IWEIR.EQ.1)FLOLEN=WRLEN
     IF(IWEIR.EQ.0)THEN
       FLOLEN=WIDTOT
       CLAK=0.3
       CLSLOPE2=-CLSLOPE
```

```
        FWD=0.
     ENDIF

C                                                              DO 870
      DO 870 IYB=1,25
      YBAS1=0.5*(YBMAX+YBMIN)
C
C  DETERMINE ADDITIONAL HEAD CHANGE ALONG WEIR.
C
      YD = Y(1)
      CALL AREA(YD,A,T,R)
      VD=QD/A
      VHEADD=VD*VD/(2*G)
      QWD=QWHC/QD
      HC=VHEADD*(1.55*QWD-QWD*QWD)
C
C  - - - - - - - - - - - - - - - - - - - - - - - -
      IF(IWEIR.EQ.1)THEN
C
C  REVERSE FLOW COMPUTATIONS FOR DOWNSTREAM END SLOPE OF WEIR.
C
C  COMPUTE Q ALONG DOWNSTREAM END SLOPE USING INCREMENTAL (DISCRETE)
C  STEPS TO REPRESENT THE END SLOPE OF THE WEIR.
C
C
        WRNDD = WRES * (YBAS1 - WRP)
        DX = -WRNDD / NDSTEP
        DXLEN = -DX
C
C  THE HEIGHT OF EACH WEIR STEP MUST BE POSITIONED SO THAT THE ACTUAL
C  WEIR END SLOPE GOES THROUGH THE MIDDLE OF EACH STEP.  (DX IS
C  NEGATIVE.)
C
        P = YBAS1 + 0.5*DX / WRES
        DHC=HC*(-DX)/FLOLEN
C
        DO 60 J = 1,NDSTEP
C
C  DX AND XLEN ARE NEGATIVE.
C
          Q(J+1)=Q(J)+FNQREV(Y(J))*DX
          XLEN(J+1) = XLEN(J) + DX
          QU=Q(J+1)
          QW=QDR(I)-Q(J+1)
          CALL AREA(Y(J),A,T,R)
          VJ=Q(J)/A
          VHJ=VJ*VJ/(2*G)
          SFJ=FNSF(Q(J),A,R)
          Y(J+1)=FNYU(Q(J),Q(J+1),Y(J),DHC,VHJ,SFJ,MANN2,DXLEN)
          YU=Y(J+1)
          ZU=ZD
          WSJ1=Y(J+1)
C
C  DETERMINE IF WATER LEVEL IN CHANNEL HAS REACHED BASIN WATER LEVEL.
C  IF SO, THE FLOW REGION IS SHORTER THAN THE WEIR LENGTH, AND THE
C  REVERSE FLOW COMPUTATION FOR THIS TRIAL IS STOPPED.
C
```

```
            IF(WSJ1 .GE. YBAS1)THEN
               FLOLEN=-XLEN(J+1)
               GOTO 69
            ENDIF
C
C  SET NEW WEIR CREST HEIGHT FOR NEXT STEP.  (DX IS NEGATIVE.)
C
            P = P + DX /WRES
C
 60      CONTINUE
      ENDIF
C
C - - - - - - - - - - - - - - - - - - - - - - -
C
C  REVERSE FLOW COMPUTATIONS FOR MAIN PART OF WEIR.
C
C
C  INITIALIZE VARIABLES FOR COMPUTATIONS ALONG MAIN PART OF WEIR.
C
      IF(IWEIR.EQ.1)THEN
         NSECT = NDSTEP + 1
         DX    = -WRLEN / NSTEP
         DXLEN = -DX
         P     = WRP
         DHC   = HC*(-DX)/FLOLEN
      ENDIF
C
      IF(IWEIR.EQ.0)THEN
         NSECT = 1
         NSTEP = NBBL
         DX    = -(CLW+0.5*CLWT)
         DXLEN = -DX
         P     = CLP
         WRP   = CLP
         DHC   = HC*(-DX)/FLOLEN
       QW=0.
      ENDIF
C
C  BEGIN COMPUTATIONS ALONG MAIN PART OF WEIR.
C
       DO 65 J = NSECT, (NSECT-1) + NSTEP
C
C  ADJUST EFFECTIVE WEIR HEIGHT TO ACCOUNT FOR LONGITUDINAL SLOPE OF
C  WEIR CREST.
C
         IF(IWEIR.EQ.1)P=WRP-FLOAT(J-NSECT)*DX*SZ
C                                                                GOTO 69
         IF(P .GE. YBAS1) GOTO 69
         WSELJ=Y(J)-(XLEN(J)-XLEN(NSECT))*SZ
C
         IF(IWEIR.EQ.1)THEN
            Q(J+1)=Q(J)+FNQREV(WSELJ)*DX
            QW=QDR(I)-Q(J+1)
         ENDIF
C
         IF(IWEIR.EQ.0)THEN
            IG=0
```

```
            HWX=ZD+YBAS1
            TWX=ZD+WSELJ
            CHF=CLH
            CWF=CLW
            CLF=CLLEN
            CIF=ZD+CLP
            COF=ZD+CLP+CLSLOPE*CLLEN
            QSO= -99.
            HSO= -99.
            TSO= -99.
            VSO= -99.
            TWXP= -99.
            TWVP= -99.
            TWVM= -99.
            CALL E2(IG,CLKE,QSO,HSO,TSO,VSO,HWX,TWX,CDI,CHF,CWF,
     &              CLF,CIF,COF,QC,TWVM)
C
            QW=QW+QC
          Q(J+1)=Q(J)-QC
          ENDIF
C
          XLEN(J+1) = XLEN(J) + DX
          QU=Q(J+1)
C
          CALL AREA(Y(J),A,T,R)
          VJ=Q(J)/A
          VHJ=VJ*VJ/(2*G)
          SFJ=FNSF(Q(J),A,R)
          Y(J+1)=FNYU(Q(J),Q(J+1),Y(J),DHC,VHJ,SFJ,MANN2,DXLEN)
          YU=Y(J+1)
          DELZ=SZ*(-(XLEN(J+1)-XLEN(NSECT)))
          ZU=ZD+DELZ
C
C  DETERMINE IF WATER LEVEL IN CHANNEL HAS REACHED BASIN WATER LEVEL.
C  IF SO, THE FLOW REGION IS SHORTER THAN THE WEIR LENGTH, AND THE
C  REVERSE FLOW COMPUTATION FOR THIS TRIAL IS STOPPED.
C
          WSJ1=Y(J+1)+DELZ
          IF(WSJ1 .GE. YBAS1)THEN
            FLOLEN=-XLEN(J+1)
            GOTO 69
          ENDIF
C
 65    CONTINUE
C
C  - - - - - - - - - - - - - - - - - - - - - - - -
C
C  REVERSE FLOW COMPUTATIONS FOR UPSTREAM END SLOPE OF WEIR.
C
C  INITIALIZE VARIABLES FOR COMPUTATIONS ALONG U/S END SLOPE OF WEIR.
C
        IF(IWEIR.EQ.1)THEN
C
          NSECT = NSECT + NSTEP
          WRPU  = WRP + WRLEN*SZ
          WRNDU  = WRES*(YBAS1 - WRPU)
C                                                         GOTO 69
```

```
         IF (WRNDU .LE. 0.) GOTO 69
         DX    = -WRNDU / NDSTEP
         DXLEN = -DX
         P     = WRP - 0.5*DX / WRES
         ZU    = ZD+SZ*WRLEN
         DHC   = HC*(-DX)/FLOLEN
C
         DO 68 J = NSECT, (NSECT-1) + NDSTEP
C
           WSELJ=Y(J)+WRLEN*SZ
           Q(J+1)=Q(J)+FNQREV(WSELJ)*DX
           XLEN(J+1) = XLEN(J) + DX
           FLOLEN=-XLEN(J+1)
           QU=Q(J+1)
           QW=QDR(I)-Q(J+1)
           CALL AREA(Y(J),A,T,R)
           VJ=Q(J)/A
           VHJ=VJ*VJ/(2*G)
           SFJ=FNSF(Q(J),A,R)
           Y(J+1)=FNYU(Q(J),Q(J+1),Y(J),DHC,VHJ,SFJ,MANN2,DXLEN)
           YU=Y(J+1)
           WSJ1=Y(J+1)+DELZ
C
C  DETERMINE IF WATER LEVEL IN CHANNEL HAS REACHED BASIN WATER LEVEL.
C  IF SO, THE FLOW REGION IS SHORTER THAN THE WEIR LENGTH, AND THE
C  REVERSE FLOW COMPUTATION FOR THIS TRIAL IS STOPPED.
C
           IF(WSJ1 .GE. YBAS1)GOTO 69
C
C
C  SET NEW WEIR STEP HEIGHT FOR NEXT STEP.  (DX IS NEGATIVE).
C
           P = P - DX/WRES
C
 68      CONTINUE
      ENDIF
C
C - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
C
C                                                                    69
 69   CONTINUE
C
C  DETERMINE BASIN WATER DEPTH FROM VOLUME OF WATER IN THE BASIN.
C
      DT = (TR(I) - TR(I-1)) * 3600.
      PDVOL(I) = PDVOL(I-1) - 0.5*(QW+QWR(I-1))*DT/43560.
C        DO 875 IP=2,NPD
         IF (PDVOL(I) .GT. VPD(IP)) GOTO 875
         YBAS2=(PDVOL(I)-VPD(IP-1))*(YPD(IP)-YPD(IP-1))/
     &         (VPD(IP)-VPD(IP-1)) + YPD(IP-1)
         GOTO 876
 875  CONTINUE
C
C  IF ACCUMULATED VOLUME IN BASIN EXCEEDS THE INPUT MAXIMUM
C  BASIN VOLUME, THEN EXTEND BASIN VERTICALLY UPWARD.
C
      YBAS2 = YPD(NPD) + (PDVOL(I)-VPD(NPD))/APD(NPD)
```

```
C                                                                  876
 876  CONTINUE
      HCCONV=HC-HCOLD
C
C  CHECK FOR CONVERGENCE OF ITERATIONS ON BASIN WATER LEVEL AND
C  ADDITIONAL HEAD CHANGE.
C
      IF(ABS(YBAS2-YBAS1) .LT. 0.01 .AND.
     &   ABS(HCCONV) .LT. 0.01) GOTO 878
      IF(YBAS2 .GT. YBAS1)YBMIN=YBAS1
      IF(YBAS2 .LT. YBAS1)YBMAX=YBAS1
      QWHC=0.5*(QW+QWHC)
      HCOLD=HC
C
 870  CONTINUE
      TCOMPJ=TCOMPJ/2.
      IF(TCOMPJ.LT.TCOMPMN)GO TO 871
      WRITE(6,260)TCOMPJ
      GO TO 53
 871  CONTINUE
      WRITE(6,258)ABS(YBAS2-YBAS1),ABS(HCCONV)
C
 878  CONTINUE
      PDY(I)=YBAS2
C                                                                  976
 976  CONTINUE
      QLSUM=0.
      QLL(I)=0.
      VQL=0.
      YPQL=0.
      IF(NDRAINC.EQ.0)GO TO 989
      IF(ZD+PDY(I)-YPD1.LT.0.01)GO TO 989
C
C     ASSUME ENTRANCE LOSS COEFFICIENT FOR DRAINAGE CULVERTS
C
      CLKE=0.40
C
      DO 977 IL=1,NDRAINC
         IG=KGATE(IL)
         HWX=ZD+PDY(I)
         TWX2=YU+ZU
         TWX1=YDR(I)+ZD
         IF(RWSTA(IL).GE.WRLEN)TWX=TWX2+(RWSTA(IL)-WRLEN)*SZ
         IF(RWSTA(IL).LE.0.)TWX=TWX1+RWSTA(IL)*SZ
         IF(RWSTA(IL).LT.WRLEN.AND.RWSTA(IL).GT.0.)
     &      TWX=RWSTA(IL)/WRLEN*(TWX2-TWX1)+(TWX1)
         CDI=CDIA(IL)
         CHF=CHFA(IL)
         CWF=CWFA(IL)
         CLF=CLFA(IL)
         CIF=CIFA(IL)
         COF=COFA(IL)
         QSO=QSOA(IL)
         HSO=HSOA(IL)
         TSO=TSOA(IL)
         VSO=VSOA(IL)
         TWXP=TWXPA(IL)
```

```
          TWVP=TWVPA(IL)
          TWVM=TWVMA(IL)
          CALL E2(IG,CLKE,QSO,HSO,TSO,VSO,HWX,TWX,CDI,CHF,CWF,
     &           CLF,CIF,COF,QC,TWVM)
C
          IF(CDI.GT.0.)SOF=COFA(IL)+CDIA(IL)/12.
          IF(CDI.LE.0.)SOF=COFA(IL)+CHFA(IL)
C
          IF(TWX.LT.SOF.AND.TSO.EQ.-99.)THEN
             TSOA(IL)=TWXPA(IL)-COFA(IL)
             VSOA(IL)=TWVPA(IL)
          ENDIF
          IF(TWX.GE.SOF.AND.TSO.NE.-99.)THEN
             TSOA(IL)= -99.
             VSOA(IL)= -99.
          ENDIF
C
          IF(TWX.LT.SOF.AND.QSO.EQ.-99.)THEN
          QSOA(IL)=QC
          HSOA(IL)=HWX
          ENDIF
C
          IF(TWX.GE.SOF.AND.QSO.NE.-99.)THEN
             QSOA(IL)= -99.
             HSOA(IL)= -99.
          ENDIF
C
          TWXPA(IL)=TWX
          TWVPA(IL)=TWVM
C
          QLSUM=QLSUM+QC
 977  CONTINUE
C
      IQL=INT(QLSUM+0.5)
      QLL(I)=FLOAT(IQL)
      VQL=QLL(I)*DT/43560.
      IF(IQL.EQ.0)GO TO 989
C
      DO 978 IP=1,NPD
         IPF=IP
         IF(PDY(I).GT.YPD(IP))GO TO 978
         IPF=IPF-1
         GO TO 983
 978  CONTINUE
C
 983   CONTINUE
       IF(IPF.EQ.NPD)APX=APD(IPF)
       IF(IPF.LT.1)  APX=APD(1)
       IF(IPF.GE.1.AND.IPF.LT.NPD)
     & APX=(PDY(I)-YPD(IPF))/(YPD(IPF+1)-YPD(IPF))
     &     *(APD(IPF+1)-APD(IPF))
     &     +APD(IPF)
       YPQL=VQL/APX
C
 989   CONTINUE
C
       QDR(I)   = QDR(I) + QLL(I)
```

```
      PDY(I)   = PDY(I) - YPQL
    PDVOL(I) = PDVOL(I) - VQL
C
C  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
C
C  END OF REVERSE FLOW COMPUTATIONS.
C
C -----------------------------------------------------------------------
C -----------------------------------------------------------------------
C
 990   CONTINUE
    PONDY    = PDY(I)
C
C  UPDATE VARIABLES.
C
      YUR(I)= YU
      QUR(I)= QU
      QWR(I)= QW
      IQU   = INT(QUR(I)+0.5)
      IQD   = INT(QDR(I)+0.5)
      IQW   = INT(QWR(I)+SIGN(0.5,QWR(I)))
      IPDV  = INT(PDVOL(I)+0.5)
C
C  CONVERT FROM DEPTH TO WATER SURFACE ELEVATION
C
      WSELD=YDR(I)+ZD
      WSELU=YUR(I)+ZU
      WSELB=PDY(I)+ZD
      DEPTHB=WSELB-YPD1
C
C  RESET ZU FOR FULL WEIR LENGTH.
C
      ZU=ZD+WRLEN*SZ
C
C  OUTPUT TO SCREEN (MONITOR), IF DESIRED, AND TO OUTPUT FILE.
C
      IQP=IQW+IQL
      IF(IQP.EQ.0)             BDLR=' '
      IF(IWEIR.EQ.1.AND.IQW.NE.0.AND.IQL.EQ.0)BDLR='W'
      IF(IWEIR.EQ.0.AND.IQW.NE.0.AND.IQL.EQ.0)BDLR='D'
      IF(IQW.NE.0.AND.IQL.NE.0)BDLR='B'
      IF(IQW.EQ.0.AND.IQL.GT.0)BDLR='C'
C
      IF(IQW .GE. 0) GOTO 981
C
      WRITE(6,95)TR(I),WSELD,YDR(I),YDA,IQD,WSELU,
     &           YUR(I),IQU,IQP,BDLR,WSELB,DEPTHB,IPDV
C
      GOTO 979
C
  981  CONTINUE
C
C
      WRITE(6,94)TR(I),WSELD,YDR(I),    IQD,WSELU,
     &           YUR(I),IQU,IQP,BDLR,WSELB,DEPTHB,IPDV
C
C - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
```

```
C
 979   CONTINUE
 980   CONTINUE
       GO TO 50
 982   CONTINUE
       NCOMP=I-1
     WRITE(*,984)
C
C  THIS IS THE END OF THE MAJOR DO LOOP FOR THE VARIOUS DEPTH AND
C  DISCHARGE PAIRS FROM THE HYDROGRAPH (I.E. THE END OF STEPPING THROUGH
C  TIME ON THE HYDROGRAPHS).
C
C---------------------------------------------------------------------
C---------------------------------------------------------------------
C---------------------------------------------------------------------
C
C  INTERPOLATE TO OBTAIN OUTPUT AT THE DESIRED TIME INTERVALS FOR
C  PLOT FILE.  TPLT MUST BE .GE. TCOMP.
C
       IF(TPLT .LE. 0.0001) GOTO 9998
       OPEN(7,FILE=PLTFIL,STATUS='UNKNOWN')
C
       IC=2
       NPLT=(TR(NCOMP)-TR(1))/TPLT+1.0001
C
       DO 84 IPLT=1,NPLT+1
         TRPLT=(IPLT-1)*TPLT+TSTR(1)
C
         IF(TRPLT .GT. (TR(IC)+0.0001)) THEN
         DO 80 II=1,NCOMP
           IC=II
           IF(TRPLT .LE. TR(IC)) GOTO 82
  80     CONTINUE
  82     CONTINUE
C
       ENDIF
C
         RATIO=(TRPLT-TR(IC-1))/(TR(IC)-TR(IC-1))
         WSDPLT=YDR(IC-1)+RATIO*(YDR(IC)-YDR(IC-1))+ZD
         QDRPLT=QDR(IC-1)+RATIO*(QDR(IC)-QDR(IC-1))
         WSBPLT=PDY(IC-1)+RATIO*(PDY(IC)-PDY(IC-1))+ZD
         QURPLT=QUR(IC-1)+RATIO*(QUR(IC)-QUR(IC-1))
         QWRPLT=QWR(IC-1)+RATIO*(QWR(IC)-QWR(IC-1))
     &    +     QLL(IC-1)+RATIO*(QLL(IC)-QLL(IC-1))
         WSUPLT=YUR(IC-1)+RATIO*(YUR(IC)-YUR(IC-1))+ZU
C
       WRITE(7,92)TRPLT,WSDPLT,QDRPLT,WSUPLT,QURPLT,QWRPLT,WSBPLT,WRELD
C
  84   CONTINUE
C
       CLOSE(7)
C
C                                                                   9998
 9998  CONTINUE
C
       CLOSE(5)
       CLOSE(6)
```

```
      GO TO 9999
C
C ---------------------------------------------------------------------
C ---------------------------------------------------------------------
C
C FORMAT STATEMENTS.
C
   3   FORMAT(1X,A)
   4   FORMAT(A1)
   5   FORMAT(//1X,'ENTER NAME OF INPUT FILE.'/1X,'INCLUDE DRIVE AND ',
     &'SUBDIRECTORY IF THESE ARE NOT THE DEFAULT DESIGNATIONS.'/1X,
     &'REMEMBER TO INCLUDE THE ENTIRE FILE DESIGNATION IN SINGLE ',
     &'QUOTE MARKS('').'/1X,'EXAMPLE - ''D:\PROJECT\RUN1.IN'' ')
   8   FORMAT(/1X,'ENTER LOCATION OF OUTPUT AND PLOT FILE NAMES.'
     &        /1X,'1 = KEYBOARD, 2 = INPUT DATA FILE.')
  11   FORMAT(/
     & /1X,'ENTER NAMES OF OUTPUT AND PLOT FILES ON THE SAME LINE.'
     & /1X,'USE A SPACE OR A COMMA AS A DELIMITER.'
     & /1X,'INCLUDE DRIVE AND SUBDIRECTORY IF THESE ARE NOT THE DEFAULT'
     &    ,'DESIGNATIONS.'
     & /1X,'REMEMBER TO INCLUDE EACH FILE DESIGNATION IN SINGLE QUOTE'
     &    ,'MARKS('')'
     & /1X,'EXAMPLE - ''D:\PROJECT\RUN1.OUT'' '' ''  ')
19    FORMAT(1X,'SIDEHYD.FOR',/,
     &1X,'DATE = ',I2,'/',I2.2,'/',I4,/,
     &1X,'TIME = ',I2,':',I2.2)
  20   FORMAT(/1X,'INPUT FILE IS  ',A/1X,'OUTPUT FILE IS ',A/
     &         1X,'PLOT FILE IS   ',A/)
 52  FORMAT('  TIME (HR) =   '\)
 54  FORMAT(F8.3\)
 90    FORMAT(/
     & 1X,'CALCULATED RESULTS'/
     & 1X,'=================')
  91   FORMAT(/
     &2X,'  TIME  ------DOWNSTREAM-------  -----UPSTREAM---- ',
     &   '---------BASIN-----------'/
     &2X,'        WS EL DPTHB DPTHA DISCH  WS EL DEPTH DISCH ',
     &   '  DISCH WS EL DEPTH   VOL'/
     &2X,'    HR     FT    FT    FT   CFS     FT    FT   CFS ',
     &   '    CFS    FT    FT    AF'/
     &2X,' ----- ------ ----- ----- -----  ----- ----- ----- ',
     &   '------- ------ ----- -----')
  92   FORMAT(1X,F8.3,F9.2,F8.0,F9.2,F8.0,F9.0,F9.2,F9.2)
  93   FORMAT(1X,'93  WARNING: CRITICAL FLOW.',I8,I8,3F8.3,F8.0)
  94   FORMAT(1X,F7.3,F7.2,F6.2,  6X,I6,F7.2,F6.2,I6,
     &          I7,A1,F6.1,F6.2,I6)
  95   FORMAT(1X,F7.3,F7.2,F6.2,F6.2,I6,F7.2,F6.2,I6,
     &          I7,A1,F6.1,F6.2,I6)
 100   FORMAT(/1X,'PROGRAM SIDEHYDR - MAY 26, 1998  VERSION'/
     &         1X,'SIDE WEIR PROGRAM'/)
 114   FORMAT(1X,'114 WARNING: EMPIRICAL EQUATIONS USED IN PROGRAM '
     & 'ARE VALID ONLY FOR SIDE SLOPES FROM 2.5 TO 4.0 '/)
 115   FORMAT(
     & 1X,'CHANNEL PARAMETERS'/
     & 1X,'=================='/
     & 1X,'  BASE WIDTH          =',F9.2,' FT'/
     & 1X,'  SIDE SLOPE          =',F9.3/
```

```
     & 1X,'  BED SLOPE           =',F9.4/
     & 1X,'  ELEV. OF D/S INVERT =',F9.2,' FT'/
     & 1X,'  MANNINGS COEF.      =',F9.3,/)
116  FORMAT(
     & 1X,'WEIR PARAMETERS'/
     & 1X,'==============='/
     & 1X,'  HEIGHT              =',F9.2,' FT'/
     & 1X,'  D/S CREST ELEV.     =',F9.2,' FT'/
     & 1X,'  U/S CREST ELEV.     =',F9.2,' FT'/
     & 1X,'  LENGTH              =',F9.1,' FT'/
     & 1X,'  CREST WIDTH         =',F9.1,' FT'/
     & 1X,'  END SLOPES          =',F9.3/)
117  FORMAT(
     & 1X,'CULVERT PARAMETERS'/
     & 1X,'=================='/
     & 1X,'  INVERT HEIGHT       =',F9.2,' FT')
118  FORMAT(
     & 1X,'  HEIGHT              =',F9.2,' FT'/
     & 1X,'  WIDTH               =',F9.2,' FT')
119  FORMAT(
     & 1X,'  WALL THICKNESS      =',F9.2,' FT')
120  FORMAT(
     & 1X,'  LENGTH              =',F9.1,' FT'/
     & 1X,'  NUMBER OF BARRELS   =',I9,/,
     & 1X,'  MANNINGS COEF.      =',F9.4,/,
     & 1X,'  ENTR. LOSS COEF.    =',F9.3,/,
     7 1X,'  SLOPE               =',F9.4)

121  FORMAT(
     & 1X,'CALCULATION PARAMETERS'/
     & 1X,'======================')
122  FORMAT(
     & 1X,'  NO. OF DX INCREMENTS ALONG CREST      =',I7/
     & 1X,'  NO. OF DX INCREMENTS ALONG END SLOPES =',I7)
123  FORMAT(
     & 1X,'  NO. OF POINTS ON INPUT D/S HYDROGRAPH =',I7/
     & 1X,'  COMPUTATIONAL TIME INCREMENT          =',F7.3,' HR'/
     & 1X,'  TIME INCREMENT FOR PLOT FILE          =',F7.3,' HR'/)
132  FORMAT(
     & 1X,'DETENTION BASIN'/
     & 1X,'==============='/
     & 1X,'    ELEV    BASIN     BASIN'/
     & 1X,'             AREA      VOL' /
     & 1X,'     FT       AC      AC-FT '/
     & 1X,'   -----    -----    -------')
133  FORMAT(1X,F8.2,F9.1,F11.1)
136  FORMAT(/,
     & 1X,'INPUT UPSTREAM HYDROGRAPH',/,
     & 1X,'=========================',/,
     & 1X,'  TIME   D/S WS     D/S      D/S',/,
     & 1X,'          ELEV     DEPTH    DISCH',/,
     & 1X,'   HR      FT        FT      CFS ',/,
     & 1X,'  ----   ------    -----    -----')
137  FORMAT(1X,F6.2,2F9.2,F10.0)
138  FORMAT(1X,'WARNING 138:',2X,
     & 'BASIN WATER SURFACE ELEVATION ABOVE MAX. INPUT ELEV.')
140  FORMAT(/,
```

```
     & 1X,'DRAINAGE CULVERTS',/,
     & 1X,'=================',/,
     & 1X,'GATE LOCATION  DIAMETER  HEIGHT  WIDTH  LENGTH  INLET ELEV',
     &    '  OUTLET ELEV',/,
     & 1X,'     REL WEIR',/,
     & 1X,'           FT        IN      FT     FT      FT          FT',
     &    '           FT',/,
     & 1X,'     --------  --------  ------  -----  ------  ----------',
     &    '  -----------')
 141   FORMAT(1X,A4,1X,F8.2,2X,F8.2,2X,F6.2,2X,F5.2,2X,F6.2,2X,F10.2,2X,
     &        F11.2)
 151   FORMAT(1X,'ERROR 151:',1X,
     & 'DIMENSION EXCEEDED.  NDRAINC > 10.')
 152   FORMAT(1X,'ERROR 152:',1X,
     & 'DIMENSION EXCEEDED.  NSTEP+2*NDSTEP+1 > 102.')
 153   FORMAT(1X,'ERROR 153:',1X,
     & 'DIMENSION EXCEEDED.  NCOMP > 9502.')
 154   FORMAT(1X,'ERROR 154:',1X,
     & 'TIDEFLEX VALVES NOT ALLOWED ON BOX CULVERTS.')
 155   FORMAT(1X,'  WARNING 155:',1X,
     & 'NUMBER OF DIVERSION CULVERT BARRELS > 3.'/)
 201   FORMAT(1X,'WARNING 860:',1X,
     & 'SEPARATION ZONE MOMENTUM DNC.  (QW1-QW)/QD    ',F6.3,' > ',F6.3)
 255   FORMAT(1X,'WARNING 861:',1X,
     & 'QW > 0.6*QU IN FINAL SOLUTION.')
 256   FORMAT(1X,'WARNING 256:',1X,
     & 'ENERGY EQUATION FOR YU IN CULVERT DIVERSION DNC.  ',
     & 'YUMAX-YUMIN(FT) =',F8.3,' FOR LAST TRIAL')
 257   FORMAT(1X,'WARNING 855:',1X,
     & 'FORWARD-FLOW BASIN LEVELS DNC. YBAS2-YBAS1(FT) =',F6.3,' > ',
     & F6.3)
 258   FORMAT(1X,'WARNING 870:',1X,
     & 'REVERSE-FLOW BASIN LEVELS DNC. YBAS2-YBAS1(FT) =',F6.3,
     &  '   HCCONV(FT) =',F6.3,' > .010')
 259   FORMAT(1X,'MESSAGE 259:',1X,
     & 'FORWARD FLOW BASIN LEVELS DNC. SET TIME STEP(HR) TO ',F10.7)
 260   FORMAT(1X,'MESSAGE 260:',1X,
     & 'REVERSE FLOW ITERATIONS DNC.   SET TIME STEP(HR) TO ',F10.7)
 261   FORMAT(1X,'WARNING 810:',1X,
     & 'UPSTREAM DEPTH CALCULATIONS DNC. DEPTH SET TO CRITICAL(FT)',
     &  F10.3)
 262  FORMAT(1X,'WARNING 262:'
     &'DIVERSION CULVERT FLOW DNC. CCTOL HWX-HWC',2X,F6.4,F9.4)
 263  FORMAT(1X)
 264   FORMAT(1X,'WARNING 264:',
     & ' TRIAL QWs FOR CULVERT DIVERSION DNC.'
     & ' QMAX-QMIN(CFS) =',F8.3,
     & ' DIFF. IN TRIAL & CALC. HW(FT) =',F8.3)
 270   FORMAT(1X, 'WARNING 270: EMPIRICAL RESULTS NOT APPLICABLE FOR ',
     &  'SUBMERGED DIVERSION CULVERTS. HW = ',F6.2,
     & ' FT  1.2*HEIGHT =',  F6.2,' FT')
 984   FORMAT(1X)
9999  CONTINUE
      END
C
C-----------------------------------------------------------------------
C
```

```
      SUBROUTINE AREA(Y, A, T, R)
C
C  THIS FUNCTION CALCULATES AREA, TOP WIDTH (T), AND HYDRAULIC RADIUS
C  FOR A TRAPEZOIDAL CROSS SECTION.
C
      REAL MANN
      COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &            WRES, WRW, G, WRLEN
C
      A = (CWIDTH + SS*Y) * Y
      T = CWIDTH + 2.*SS*Y
      WP = CWIDTH + 2.*Y*SQRT(1 + SS**2)
      R = A / WP
C
      RETURN
      END
C
C-----------------------------------------------------------------------
C
      SUBROUTINE YCRIT(YCMAX,Q,YCR)
C
C     THIS SUBROUTINE COMPUTES CRITICAL DEPTH, GIVEN THE FLOW.
C
      COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &            WRES, WRW, G, WRLEN
C
C
      YZMAX=YCMAX
      YCR=0.
      IF(YZMAX.LE.0.)GO TO 200
      IF(Q.LE.0.)GO TO 200
C
      YZMIN=0.
      FLHS=Q*Q/G
      DO 100 IYC=1,25
       YCR=0.5*(YZMAX+YZMIN)
       CALL AREA(YCR,A,T,R)
       RHS=A**3/T
       IF(ABS(FLHS/RHS-1) .LT. .001)GOTO 200
       IF(RHS .GT. FLHS)YZMAX=YCR
       IF(RHS .LT. FLHS)YZMIN=YCR
 100  CONTINUE
C
 200  CONTINUE
      RETURN
      END
C
C-----------------------------------------------------------------------
C
     SUBROUTINE GVF(Q, YJ, DX, YJP1)
C
C  GIVEN Q AND Y AT ONE CROSS SECTION AND THE DISTANCE TO THE NEXT
C  CROSS SECTION, GVF CALCULATES Y AT THE NEXT CROSS SECTION USING
C  A FORTH-ORDER RUNGE-KUTTA METHOD FOR SIMPLE GRADUALLY VARIED FLOW
C  WITH NO FLOW IN EITHER DIRECTION OVER THE WEIR.  THIS SUBROUTINE
C  CALLS VARIOUS FUNCTIONS AND OTHER SUBROUTINES TO EVALUATE THE
C  RELATIONSHIPS REQUIRED TO OBTAIN THE NEXT UPSTREAM Y.
```

```
C
        REAL         K0, K1, K2, K3
        REAL         FNSF, FNFR, FNYGVF, MANN
        LOGICAL      QCRIT
C
        COMMON /BB/  QCRIT
        COMMON /CC/  CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &               WRES, WRW, G, WRLEN
C
C  CALCULATE THE RUNGE-KUTTA PARAMETERS K0, K1, K2, K3.
C
C-----------------------------------------------------------------------
C
C BEGIN FIRST PASS THROUGH THE RUNGE-KUTTER INTEGRATION (K0).
C
        CALL AREA(YJ, A, T, R)
C
        SF = FNSF(Q, A, R)
        FR = FNFR(Q, A, T)
C
C  ALWAYS CHECK THAT THE FROUDE NO. IS LESS THAN 1. IF IT IS GREATER
C  THAN 1, RETURN.
C
        IF (FR .GE. 0.999) THEN
           QCRIT = .TRUE.
           YJP1 = YJ
           RETURN
        END IF
C
CDIAG   WRITE(6,101)Q,YJ,SF,A,T
101     FORMAT(1X,'101 Q YJ SF A T',5F15.5)
C
        K0 = DX * FNYGVF(Q, YJ, SF, A, T)
C
CDIAG   WRITE(6,102)K0,DX,FNYGVF(Q,YJ,SF,A,T)
102     FORMAT(1X,'102 K0 DX FNYGVF',3F15.5)
C
C-----------------------------------------------------------------------
C
C BEGIN SECOND PASS THROUGH THE RUNGE-KUTTER INTEGRATION (K1).
C
        YJ2 = YJ + 0.5*K0
CDIAG   WRITE(6,103)YJ2,YJ,K0
103     FORMAT(1X,'103 YJ2=YJ+0.5*K0',3F15.5)
        CALL AREA(YJ2, A, T, R)
C
        SF = FNSF(Q, A, R)
        FR = FNFR(Q, A, T)
C
C  CHECK THAT FR < 1.
C
        IF (FR .GE. 0.999) THEN
           QCRIT = .TRUE.
           YJP1 = YJ2
           RETURN
        END IF
C
```

```
      K1 = DX * FNYGVF(Q, YJ2, SF, A, T)
C
C-----------------------------------------------------------------------
C
C BEGIN THIRD PASS THROUGH THE RUNGE-KUTTER INTEGRATION (K2).
C
      YJ2 = YJ + 0.5*K1
      CALL AREA(YJ2, A, T, R)
C
      SF = FNSF(Q, A, R)
      FR = FNFR(Q, A, T)
C
C  CHECK THAT FR < 1.
C
      IF (FR .GE. 0.999) THEN
         QCRIT = .TRUE.
         YJP1 = YJ2
         RETURN
      END IF
C
      K2 = DX * FNYGVF(Q, YJ2, SF, A, T)
C
C-----------------------------------------------------------------------
C
C BEGIN FOURTH PASS THROUGH THE RUNGE-KUTTER INTEGRATION (K3).
C
      YJ2 = YJ + K2
      CALL AREA(YJ2, A, T, R)
C
      SF = FNSF(Q, A, R)
      FR = FNFR(Q, A, T)
C
C  CHECK THAT FR < 1.
C
      IF (FR .GE. 0.999) THEN
         QCRIT = .TRUE.
         YJP1 = YJ2
         RETURN
      END IF
C
      K3 = DX * FNYGVF(Q, YJ2, SF, A, T)
C
C-----------------------------------------------------------------------
C
C END OF PASSES THROUGH THE RUNGE-KUTTER INTEGRATION.
C CALCULATE Y AT THE NEXT CROSS SECTION.
C
      YJP1 = YJ + (K0 + 2.*K1 + 2.*K2 + K3)/6.
C
      RETURN
      END
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
C
      REAL FUNCTION FNFR(Q, A, T)
C
```

```
C  THIS FUNCTION CALCULATES THE CHANNEL FROUDE NUMBER (FNFR).
C
        COMMON /CC/  CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &               WRES, WRW, G, WRLEN
C
        FNFR = Q * SQRT(T/(G*A**3))
        RETURN
        END
C
C----------------------------------------------------------------------
C----------------------------------------------------------------------
C
        REAL FUNCTION FNQREV(Y)
C
C  THIS FUNCTION CALCULATES FNQREV (WHICH IS dQ/dX, I.E., THE FLOW OVER
C  THE WEIR PER UNIT LENGTH OF WEIR CREST) FOR REVERSE FLOW.
C
        DIMENSION HPDAT(13), MLDAT(13), CSDAT(11), SRDAT(11), SRNEW(11)
C
        REAL      MLDAT, ML, MANN
C
        COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &              WRES, WRW, G, WRLEN
        COMMON /DD/ YD,YU
C
        DATA HPDAT /0.0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7,
     &                 0.8, 0.9, 1.0, 1.5, 2.0 /
     &      MLDAT /0.73, 0.73, 0.775, 0.805, 0.83, 0.845,
     &                 0.86, 0.875, 0.885, 0.895, 0.9, 0.93, 0.93 /
     &      CSDAT /0.992, 0.988, 0.975, 0.956, 0.93, 0.88, 0.82,
     &                 0.72, 0.576, 0.465, 0.0 /
     &      SRDAT /0.82, 0.84, 0.86, 0.88, 0.9, 0.92, 0.94,
     &                 0.96, 0.98, 0.99, 1.0 /
C
        TOL    = 0.001
        CS     = 1.0
        ML     = 0.73
C
100        FORMAT(1X,'PONDY P Y HW HT',5F12.8)
           HW = PONDY - P
           HT = Y - P
           IF(HW.EQ.0.) THEN
              FNQREV = 0.
              RETURN
           ENDIF
           SR = HT/HW
           HP = HW/P
C
           IF(SR .GE. 1.) THEN
              FNQREV = 0.
              RETURN
           ENDIF
C
C----------------------------------------------------------------------
C
C  COMPUTE COEFFICIENT OF SUBMERGENCE, CS.
C
```

```
C  CS IS DIFFERENT FROM 1 ONLY IF SUBMERGENCE RATIO (SR) > MODULAR
C  LIMIT (ML).  THE INPUT CS VALUES AS A FUNCTION OF HP ARE FOR ML =
C  0.82.  THE CS VALUES ARE SCALED BASED ON THE ACTUAL ML FOR EACH FLOW
C  CONDITION.
C
C  DETERMINE ML FOR EACH FLOW CONDITION BASED ON HP.
C
           DO 10 I = 1, 13
              IF (HP .GT. HPDAT(I)) GO TO 10
              ML =(MLDAT(I)-MLDAT(I-1))/(HPDAT(I)-HPDAT(I-1))
     &             * (HP - HPDAT(I-1)) + MLDAT(I-1)
              GO TO 20
  10       CONTINUE
C
C  HP > 2. THEREFORE, ASSIGN ML = 0.93.
C
           ML = 0.93
  20       CONTINUE
C
           IF (SR .LE. ML) GO TO 40
C
C  EXPAND CS DATA TO REFLECT THE ML BEING USED.  THE DATA PROVIDED IN
C  THE PROGRAM ARE FOR ML = 0.82.  THE DATA ARE LINEARLY EXPANDED OR
C  CONTRACTED FOR VARYING ML VALUES.
C
           DO 30 I = 1, 11
              SRNEW(I) = 1 - (1-SRDAT(I))*(1-ML)/(1-0.82)
C
C  NEED ONLY EXPAND DATA UP TO THE VALUE OF SR.  ONLY THE DATA
C  BRACKETING THE VALUE OF SR ARE USED.
C
           IF (SR .GT. SRNEW(I)) GO TO 30
              CS = CSDAT(I) + (CSDAT(I-1) - CSDAT(I))
     &             * (SR - SRNEW(I))/(SRNEW(I-1) - SRNEW(I))
              GO TO 40
  30       CONTINUE
C
  40    CONTINUE
C
C-----------------------------------------------------------------------
C
C  COMPUTE DISCHARGE COEFFICIENT FOR UNSUBMERGED CONDITIONS.
C
        CN  = 0.923+0.08*HW/WRW
C
C  COMPUTE DISCHARGE.
C
        FNQREV = CN * CS * (2./3.) * SQRT(2.*G/3.) * HW**1.5
C
        RETURN
        END
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
C
        REAL FUNCTION FNSF(Q, A, R)
C
```

```
C  THIS FUNCTION CALCULATES THE FRICTION SLOPE (FNSF) USING MANNINGS
C  EQUATION FOR ENGLISH UNITS.
C
        REAL MANN
        COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &             WRES, WRW, G, WRLEN
C
        FNSF = (Q*MANN /(1.49*A*R**(0.666667)))**2
        RETURN
        END
C
C----------------------------------------------------------------------
C----------------------------------------------------------------------
C
        REAL FUNCTION FNYGVF(Q, Y, SF, A, T)
C
C  THIS FUNCTION CALCULATES FNYGVF, WHICH IS dY/dX FOR THE CHANNEL FOR
C  SIMPLE GRADUALLY VARIED FLOW WITH NO FLOW IN EITHER DIRECTION OVER
C  THE WEIR.
C
        REAL MANN
        COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &             WRES, WRW, G, WRLEN
C
        FNYGVF=(SZ - SF)/(1 - BETA*Q**2*T/(A**3*G))
C
        RETURN
        END
C
C----------------------------------------------------------------------
C----------------------------------------------------------------------
C
        REAL FUNCTION FNYU(QD,QU,YD,HC,VHEADD,SFD,MANN2,DXLEN)
C
C  THIS FUNCTION CALCULATES THE UPSTREAM CHANNEL DEPTH FROM THE ENERGY
C  EQUATION.

        COMMON /CC/  CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &              WRES, WRW, G, WRLEN
        REAL MANN2
C
C CALCULATE UPSTREAM CRITICAL DEPTH TO USE AS LOWER LIMIT IN TRIALS FOR
C DETERMINING THE UPSTREAM DEPTH.
C
       YCRMAX=2.*YD
       YCRMIN=0.
       FLHS=QU*QU/G
C
       DO 100 ID=1,25
          YCR=0.5*(YCRMAX+YCRMIN)
          CALL AREA(YCR,A,T,R)
          RHS=A**3/T
          IF(ABS(FLHS/RHS-1.) .LT. 0.001) GOTO 150
          IF (RHS .GT. FLHS) YCRMAX=YCR
          IF (RHS .LT. FLHS) YCRMIN=YCR
 100   CONTINUE
C
```

```
      WRITE(6,500) ID,YD,QD,QU,YCR,YCRMAX,YCRMIN
      CLOSE(5)
      CLOSE(6)
      CLOSE(7)
      STOP
C
 150  CONTINUE
C
C  DETERMINE UPSTREAM DEPTH FROM ENERGY EQ. BY TRIAL.
C
       YUMAX = 2.*YD
       YUMIN = YCR
       DO 200 ITRY=1,25
          YU1 = 0.5*(YUMAX + YUMIN)
          CALL AREA(YU1, A, T, R)
          VU=QU/A
          VHEADU=VU*VU/(2*G)
          SFU=(QU/(A*R**.6667))**2*MANN2
          FNYU=YD+VHEADD+DXLEN*(0.5*(SFD+SFU)-SZ)+HC-VHEADU
          IF (ABS(YU1-FNYU) .LE. 0.01) RETURN
          IF (YU1 .GT. FNYU) YUMAX = YU1
          IF (YU1 .LT. FNYU) YUMIN = YU1
  200  CONTINUE
       WRITE(6,600) ITRY,YD,QD,QU,YCR,FNYU,YU1,YUMAX,YUMIN
       CLOSE(5)
       CLOSE(6)
       CLOSE(7)
       STOP
C
 500   FORMAT(/1X,'CRITICAL DEPTH CALCULATION DID NOT CONVERGE IN ',
    &     'FUNCTION FNYU.'/1X,'ID,YD,QD,QU,YCR,YCRMAX,YCRMIN'/
    &         1X,I4,6E12.4)
C
 600   FORMAT(/1X,'UPSTREAM DEPTH CALCULATION DID NOT CONVERGE IN ',
    &            'FUNCTION FNYU.'/1X,'ITRY,YD,QD,QU,YCR,FNYU,',
    &            'YU1,YUMAX,YUMIN'/1X,I4,8E12.4)
C
       END
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
C
      REAL FUNCTION YBAR(Y,B,SS,A)
C
C  THIS FUNCTION CALCULATES CENTROID OF TRAPEZOIDAL FLOW AREA FOR
C  CALCULATION OF PRESSURE FORCE IN MOMENTUM EQUATION.
C
CERH  YBAR=(Y*Y*B/2+Y*Y*Y*SS/3)/A
      YBAR= B/2. + Y*SS/3.
      YBAR=YBAR/((B/Y)+SS)
      RETURN
      END
C
C-----------------------------------------------------------------------
C-----------------------------------------------------------------------
C
       REAL FUNCTION YULEN(QD,QU,YD,HC,VHEADD,SFD,MANN2,DXLEN)
```

```
C
C  THIS FUNCTION CALCULATES THE UPSTREAM CHANNEL DEPTH FROM THE ENERGY
C  EQUATION.

        COMMON /CC/  CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &               WRES, WRW, G, WRLEN
        REAL MANN2
C
C CALCULATE UPSTREAM CRITICAL DEPTH TO USE AS LOWER LIMIT IN TRIALS FOR
C DETERMINING THE UPSTREAM DEPTH.
C
       YCRMAX=2.*YD
       YCRMIN=0.
       FLHS=QU*QU/G
C
       DO 100 ID=1,25
          YCR=0.5*(YCRMAX+YCRMIN)
          CALL AREA(YCR,A,T,R)
          RHS=A**3/T
          IF(ABS(FLHS/RHS-1.) .LT. 0.001) GOTO 150
          IF (RHS .GT. FLHS) YCRMAX=YCR
          IF (RHS .LT. FLHS) YCRMIN=YCR
 100   CONTINUE
C
       WRITE(6,500) ID,YD,QD,QU,YCR,YCRMAX,YCRMIN
       CLOSE(5)
       CLOSE(6)
       CLOSE(7)
       STOP
C
 150   CONTINUE
C
C  DETERMINE UPSTREAM DEPTH FROM ENERGY EQ. BY TRIAL.
C
        YUMAX = 2.*YD
        YUMIN = YCR
        DO 200 ITRY=1,25
           YU1 = 0.5*(YUMAX + YUMIN)
           CALL AREA(YU1, A, T, R)
           VU=QU/A
           VHEADU=VU*VU/(2*G)
           SFU=(QU/(A*R**.6667))**2*MANN2
           YULEN=YD+VHEADD+DXLEN*(0.5*(SFD+SFU)-SZ)+HC-VHEADU
           IF (ABS(YU1-YULEN) .LE. 0.01) RETURN
           IF (YU1 .GT. YULEN) YUMAX = YU1
           IF (YU1 .LT. YULEN) YUMIN = YU1
  200   CONTINUE
        WRITE(6,600) YCR,YULEN
        YULEN=999999.
        RETURN
C
 500    FORMAT(/1X,'CRITICAL DEPTH CALCULATION DID NOT CONVERGE IN ',
     &     'FUNCTION YULEN.'/1X,'ID,YD,QD,QU,YCR,YCRMAX,YCRMIN'/
     &         1X,I4,6E12.4)
C
 600    FORMAT(1X,'FOLLOWING UPSTREAM DEPTH CALCULATION DID NOT ',
     &     'CONVERGE IN FUNCTION YULEN.'/1X,'WEIR MAY BE SO LONG THAT ',
```

```
     &     'CALCULATED U/S DEPTH IS BELOW Y CRITICAL,'/
     &  1X,'WHICH IS',F8.2, ' FT.  LAST TRIAL U/S DEPTH =',F8.2,' FT.')
C
      END
C
C-----------------------------------------------------------------------
C
      SUBROUTINE DIVCULV(CLAK,CLXUS,CLXDS,CLSLOPE,
     .                   CLENDEL,DEP,FWD,YD,ZU,YUC,QW,IERR)
C
      COMMON /LEEDATA/ WIDBBLS,WIDTOT,CLMANN,ANBBL
      COMMON /CULVERT/ YUMAX,YUMIN,QMAX,QMIN,CLHWX,CLHWC
      COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &             WRES, WRW, G, WRLEN
C
C  Q = upstream discharge
C  WIDBBLS = total width of barrels
C  WIDTOT = width outside barrels, i.e. total width of barrels +
C          wall thickness
C  CLSLOPE = longitudinal slope of culvert
C  CLMANN = Manning's n
C  AK = entrance loss coefficient
C  N = number of cases to be calculated
C  CLXUS = x-coordinate of entrance of barrels
C  CLXDS = x-coordinate of end of barrels
C  CLENDEL = elevation of culvert invert at X0
C  DEP = depth of flow at downstream end of barrels
C  CHELV = water surface elevation in channel
C  VCHU = upstream channel velocity
C  VCHD = downstream channel velocity
C  VCHA = average of VCHU and VCHD
C  Z_ = elevation
C  Y_ = flow depth
C  V_ = velocity
C  H_ = total head
C  SF_ = friction slope
C  YC = critical depth
C
      ICCMAX=31
      CCTOL=0.001
      HWX=YD-P
      QMAX=WIDTOT*SQRT(G*HWX**3)
      QMIN=0.
      QX=0.
      IF(HWX.LE.0.)GO TO 1900
      IF(DEP.GE.HWX)GO TO 1900
      ICC=0
50    CONTINUE
      ICC=ICC+1
      IF(ICC.GT.ICCMAX)GO TO 1800
      QX=0.5*(QMAX+QMIN)
C
      IERR=0
C  CLXUS IS NEGATIVE.  DELX IS POSITIVE.
      DELX=-(CLXDS-CLXUS)/4.
      ABSDELX=ABS(DELX)
      YC=((QX/WIDBBLS)**2/G)**(1./3.)
```

```
      X1=CLXDS
      Z1=CLENDEL
      Z2=CLENDEL
      IF(DEP.LE.YC) THEN
       Y1=YC
       Y2=YC
      ELSE
       Y1=DEP
       Y2=DEP
      ENDIF
      Y1I=Y1
C
C  Calculate variables at end of barrels.
      CALL CAL(QX,Y1,Z1,1,V1,H1,SF1)
C
C  Gradually varied flow in barrels.
C  1 for downstream cross section, 2 for upstream cross section.
C  Initial guess of Y2 is Y1.
C
      DO 100 I=1,4
      X2=X1-ABSDELX
      Z2=Z2+ABSDELX*CLSLOPE
150   CALL CAL(QX,Y2,Z2,1,V2,H2,SF2)
      Y=H1+(SF1+SF2)/2.*ABSDELX-V2**2/64.4-Z2
      IF(ABS(Y-Y2)/Y2 .LT. 0.001) THEN
        Y1=Y2
        Z1=Z2
        X1=X2
        CALL CAL(QX,Y1,Z1,1,V1,H1,SF1)
        GOTO 100
      ELSE
        IF(Y.LT.YC) THEN
          WRITE(6,90) Y,YC
          Y=YC
 90       FORMAT(1X,'WARNING 90: Depth in culvert less than critical.'
     .             ,2F8.1)
        ENDIF
        Y2=Y
        GOTO 150
      ENDIF
100   CONTINUE
C
C  Calculate depth just upstream of barrel entrance.
C
C  Entrance loss = CLAK*(V1**2-V2**2)/64.4
C
      H1=H1+CLAK*V1**2/64.4
      Y2=Y1
200   CALL CAL(QX,Y2,Z1,2,V2,H2,SF2)
      Y=H1-(1+CLAK)*V2**2/64.4-Z1
      IF(ABS(Y-Y2)/Y2.LT.1E-4) THEN
        Y1=Y2
      ELSE
        Y2=Y
        GOTO 200
      ENDIF
      CALL CAL(QX,Y1,Z1,2,V1,H1,SF1)
```

```
C
C    Calculate upstream depth in channel
C
      YCMAX=2.*YD
      CALL YCRIT(YCMAX,QU,YCC)
      AKE=0.248*(Y1I/YC)*10.**(2.50*FWD)
C FOR SMALL HEADS, AKE MAY BE VERY LARGE.  THE FOLLOWING STATEMENT
C PUTS A LIMIT OF 10. ON THE MAXIMUM VALUE OF AKE.
      IF (AKE .GT. 10.) AKE=10.
      RHS=Y2+Z2+(1.+AKE)*(V2**2)/(2.*G)-ZU
      YUMAX=5.*YD
      YUMIN=YCC
      DO 300 I=1,25
        YUC=0.5*(YUMAX+YUMIN)
        CALL AREA(YUC,A,T,R)
        FLHS=YUC+((QU/A)**2)/(G*2.)
        IF(ABS(FLHS/RHS-1.)  .LT.  0.0001) GOTO 325
        IF(RHS .LT. FLHS) YUMAX=YUC
        IF(RHS .GT. FLHS) YUMIN=YUC
300   CONTINUE
      IERR=1
325   CONTINUE
      HWC=YUC-P
      IF(ABS(HWX-HWC).LT.CCTOL)GO TO 1900
      IF(ABS(QMAX-QMIN).LT.0.005.AND.ABS(HWX-HWC).LT.0.01)GO TO 1900
      IF(HWC.GT.HWX)QMAX=QX
      IF(HWC.LT.HWX)QMIN=QX
      GO TO 50
C
1800  CONTINUE
      QX=(QMAX+QMIN)/2.
      IERR=2
C
1900  CONTINUE
      QW=-QX
C
      RETURN
      END
C
C  Subroutine to calculate velocity, total head and friction slope.
C
      SUBROUTINE CAL(QW,Y,Z,IC,V,H,SF)
      COMMON /LEEDATA/ WIDBBLS,WIDTOT,CLMANN,ANBBL
      COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &             WRES, WRW, G, WRLEN
      IF(IC.EQ.1) THEN
        B=WIDBBLS
      ELSE
      B=WIDTOT
      ENDIF
      A=Y*B
      PERIM=2.*Y*ANBBL+B
      RH=A/PERIM
      V=QW/A
      H=Z+Y+V**2/(2.*G)
      SF=(CLMANN*V/(1.49*RH**(2./3.)))**2
      RETURN
```

```
      END
C
C
      SUBROUTINE CALCQW(QU,HT,HU,HD,QD,NSTEP,NDSTEP,IND)
      REAL MANN
      COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &            WRES, WRW, G, WRLEN
C
C     Original version written by:  Lee, Ka Leung
C
C     Given the weir geometry, upstream discharge and downstream head on
C     weir, this program gives the side weir discharge and upstream head
C     on weir (Lee's analysis).
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C  NSTEP = number of segments the side weir is divided into
C  NDSTEP = number of segments the downstream end slope is divided into
C  DBETA = d(beta)/dx
C  CWIDTH = bottom width
C  SS = side slope
C  QU = upstream discharge
C  SZ = channel slope
C  WRLEN = weir length
C  BETA0 = beta for no diversion
C  C1 = side weir discharge coefficient
C  C2 = coefficient (see subroutine WSLOPE)
C  P = weir height
C  QW = side weir discharge
C  HU = upstream head on the weir
C  HD = downstream head on the weir
C  HUC = calculated upstream head on the weir
C  QWC = calculated side weir discharge
C  Y = flow depth in channel
C  A = cross-sectional area
C  T = width of water surface
C  G = acceleration due to gravity
C  RH = hydraulic radius
C
C  IND = 1      a solution is obtained
C  IND = -1     Qw > Qu, iteration stopped
C  IND = -2     negative flow depth, iteration stopped
C  IND = -3     critical/supercritical condition in final solution
C  IND = -4     Qw > 0.6*Qu in final solution
C
C  IFLAG = 1    for checking critical condition in final solution,
C               otherwise, IFLAG = 0
C
C
C  SL is slope, ROG is Manning's n.
C
C
C  A1, A2, A3, A4, A5 are coefficients of regression equation.
C
      A125=-0.2502
      A225=-0.4632
      A325=1.943
```

```
      A425=0.5758
      A525=0.6119
      C225=0.85
C
      CERH=1.10
      A140=-0.2502*CERH
      A240=-0.4632*CERH
      A340=1.943*CERH
      A440=0.5758*CERH
      A540=0.6119*CERH
      C240=1.10
C
      C2=C225+(C240-C225)*(SS-2.5)/(4.0-2.5)
      HU=-99.
C
      IFLAG=1
C
C  Checking.  If YD is less than the critical depth corresponding to
C  QU, then there is no solution.
C
      YD=HD+P
      AD=(CWIDTH+SS*YD)*YD
C
C  Initial guess of side weir discharge = 0.1*QU
C
      IND=1
      VD=QD/AD
      FW=VD/SQRT(G*HD)
      C125=EXP(A125+A225*(LOG(FW+1.))**A325+A425*(LOG(HD/P+1.))**A525)
      C140=EXP(A140+A240*(LOG(FW+1.))**A340+A440*(LOG(HD/P+1.))**A540)
      C1=C125+(C140-C125)*(SS-2.5)/(4.0-2.5)
      IF(HT/HD.GT.0.5)THEN
        CS=1.002 - 19.5*(HT/HD-0.5)**4.5 - 5.618*(LOG(FW+1.))**3.965
      ELSE
        CS=1.
      ENDIF
      IF(CS.LT.0.)
     &  CS=0.887-22.62*(HT/HD-0.5)**4.76
C
C  For diversion > 60%, beta is found by extrapolation.
C
            IF(QW/QU.GT.0.6) THEN
              IND=-4
            ELSE
              IND=1
            ENDIF
            BETA025=1.08
            BETA040=1.12
            BETA0=BETA025+(BETA040-BETA025)*(SS-2.5)/(4.0-2.5)
C
            DBETA=(BETA-BETA0)/WRLEN
            Y=P+HD
C
C  Compute discharge over downstream end slope
C
C  WRES = weir end slope
C  EX = length of wedge above end slope
```

```
C
            EX=HD*WRES
            DEX=EX/FLOAT(NDSTEP)
            X=DEX/2.
            Q=QD
            DO 150 I=1,NDSTEP
              IF(IFLAG.EQ.1) THEN
                FRSQ=CRIT(Y,Q)
                IF(FRSQ.GE.1.) THEN
                  IND=-3
C
                ENDIF
              ENDIF
              EP=P+(EX-X)/50.*(25.-P)
              Q=Q+SDIS(C1,CS,Y,EP)*DEX
              X=X+DEX
150         CONTINUE
C
C  Compute water surface profile and discharge over weir crest.
C  In the following part, x is positive downstream.
C  The computation proceeds in the upstream direction.
C  X = 0 at the downstream end of the weir crest.
C  Runge-Kutta method is used.
C
            DX=WRLEN/FLOAT(NSTEP)*(-1.)
            X=0.
            DO 200 I=1,NSTEP
              IF(IFLAG.EQ.1) THEN
                FRSQ=CRIT(Y,Q)
                IF(FRSQ.GE.1.) THEN
                  IND=-3
C                 GOTO 350
                ENDIF
              ENDIF
              IF(Y.LE.0.) THEN
                IND=-2
                GOTO 300
              ENDIF
              AK0=DX*WSLOPE(DBETA,BETA0,C1,C2,CS,X,Y,Q)
              AM0=DX*SDIS(C1,CS,Y,P)*(-1.)
              X1=X+DX/2.
              Y1=Y+AK0/2.
              Q1=Q+AM0/2.
              IF(IFLAG.EQ.1) THEN
                FRSQ=CRIT(Y1,Q1)
                IF(FRSQ.GE.1.) THEN
                  IND=-3
C                 GOTO 350
                ENDIF
              ENDIF
              IF(Y1.LE.0.) THEN
                IND=-2
                GOTO 300
              ENDIF
              AK1=DX*WSLOPE(DBETA,BETA0,C1,C2,CS,X1,Y1,Q1)
              AM1=DX*SDIS(C1,CS,Y1,P)*(-1.)
              X2=X+DX/2.
```

```
            Y2=Y+AK1/2.
            Q2=Q+AM1/2.
            IF(IFLAG.EQ.1) THEN
              FRSQ=CRIT(Y2,Q2)
              IF(FRSQ.GE.1.) THEN
                IND=-3
C               GOTO 350
              ENDIF
            ENDIF
            IF(Y2.LE.0.) THEN
              IND=-2
              GOTO 300
            ENDIF
            AK2=DX*WSLOPE(DBETA,BETA0,C1,C2,CS,X2,Y2,Q2)
            AM2=DX*SDIS(C1,CS,Y2,P)*(-1.)
            X3=X+DX
            Y3=Y+AK2
            Q3=Q+AM2
            IF(IFLAG.EQ.1) THEN
              FRSQ=CRIT(Y3,Q3)
              IF(FRSQ.GE.1.) THEN
                IND=-3
C               GOTO 350
              ENDIF
            ENDIF
            IF(Y3.LE.0.) THEN
              IND=-2
              GOTO 300
            ENDIF
            AK3=DX*WSLOPE(DBETA,BETA0,C1,C2,CS,X3,Y3,Q3)
            AM3=DX*SDIS(C1,CS,Y3,P)*(-1.)
            Y=Y+(AK0+2.*AK1+2.*AK2+AK3)/6.
            Q=Q+(AM0+2.*AM1+2.*AM2+AM3)/6.
            X=X+DX
200       CONTINUE
          HUC=Y-P
          QWC=Q-QD
C
          QW=-(Q-QD)
          GO TO 900
300   CONTINUE
      CALL YCRIT(YCMAX,Q,YCR)
      Y=YCR
C
900   CONTINUE
      QU=Q
      HU=Y-P
C
999   CONTINUE
      RETURN
      END
C-----------------------------------------------------------------------
      FUNCTION WSLOPE(DBETA,BETA0,C1,C2,CS,X,Y,Q)
      REAL MANN
      COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &            WRES, WRW, G, WRLEN
C
```

```
C     WSLOPE gives dy/dx.
C
      A=(CWIDTH+SS*Y)*Y
      T=CWIDTH+2.*SS*Y
      BETAX=DBETA*(WRLEN+X)+BETA0
      V=Q/A
      RH=A/(CWIDTH+2*SQRT(1.+SS**2.)*Y)
      SF=FRICT(V,RH)
      QQW=SDIS(C1,CS,Y,P)*(-1.)
      WSLOPE=SZ-SF+QQW*V/(G*A)*(C2*Y/P-2.*BETAX)-V**2.*DBETA/G
      WSLOPE=WSLOPE/(1.-BETAX*T*V**2./(G*A))
      RETURN
      END
C
C  SDIS gives the side weir discharge.
C
      FUNCTION SDIS(C1,CS,Y,PP)
      REAL MANN
      COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &            WRES, WRW, G, WRLEN
      H=Y-PP
      IF(H.LT.0.) H=0.
      SDIS=C1*CS*(2./3.)**(3./2.)*SQRT(G)*H**(3./2.)
      RETURN
      END
C
C  FRICT gives the friction slope.
C  MANN is Manning's n.
C
      FUNCTION FRICT(V,RH)
      REAL MANN
      COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &            WRES, WRW, G, WRLEN
      FRICT=MANN**2.*V**2./(2.22*RH**(4./3.))
      RETURN
      END
C
C  CRIT calculate square of the channel Froude number.
C
      FUNCTION CRIT(Y,Q)
      REAL MANN
      COMMON /CC/ CWIDTH, SS, SZ, WRP, P, PONDY, BETA, MANN,
     &            WRES, WRW, G, WRLEN
      A=(CWIDTH+SS*Y)*Y
      CRIT=Q**2.*(CWIDTH+2.*SS*Y)/(G*A**3.)
      RETURN
      END

C
C-----------------------------------------------------------------------
C
      SUBROUTINE JSTR(ADLR,CDLR)
      CHARACTER*80 ADLR
      CHARACTER*20 CDLR
      CHARACTER*1 BDLR
      DIMENSION BDLR(80)
C
```

```
      CDLR=" "
      READ(ADLR,10)(BDLR(I),I=1,80)
10    FORMAT(80A1)
C
      DO 20 I=1,80
      IF(BDLR(I).EQ.",")BDLR(I)=" "
      IF(BDLR(I).EQ."'")BDLR(I)=" "
20    CONTINUE
C
      DO 30 I=1,80
      ICF=I
      IF(BDLR(I).NE." ")GO TO 35
30    CONTINUE
      GO TO 90
35    CONTINUE
      DO 40 I=ICF,80
      ICL=I
      IF(BDLR(I).EQ." ")GO TO 45
40    CONTINUE
      ICL=ICL+1
45    CONTINUE
      ICL=ICL-1
C
      WRITE(ADLR,50)(BDLR(I),I=ICL+1,80)
50    FORMAT(80A1)
      WRITE(CDLR,60)(BDLR(I),I=ICF,ICL)
60    FORMAT(20A1)
90    CONTINUE
      RETURN
      END
      SUBROUTINE LENCHR (STRING,ILEN)
      CHARACTER*(*)    STRING
      INTEGER          ILEN
      INTEGER          I,LENSTR,IRETN,CVAL
C
      IRETN = 0
      ILEN = 0
      LENSTR = LEN(STRING)
      DO 100 I = 1,LENSTR
        CVAL = ICHAR(STRING(I:I))
        IF (CVAL.LT.32 .OR. CVAL.GT.127) GOTO 200
  100 CONTINUE
      I = LENSTR + 1
  200 LENSTR = I - 1
C
      DO 300 I=LENSTR,1,-1
        IF (STRING(I:I) .NE. ' ') GOTO 400
  300 CONTINUE
      GOTO 9900
  400 ILEN = I
      IRETN = ILEN
C
 9900 CONTINUE
      RETURN
      END

C
```

```
C---------------------------------------------------------------------
C
      SUBROUTINE E2(IG,CLKE,QSO,HSO,TSO,VSO,HWX,TWX,CDI,CHF,CWF,
     &              CLF,CIF,COF,QC,TWVM)
      ICCMAX=30
      CCTOL=0.001
      QMAX=9999.
      QMIN=0.
      QX=0.
      IF(CIF.GT.HWX)GO TO 900
      IF(COF.GT.HWX)GO TO 900
      IF(TWX.GE.HWX)GO TO 900
      ICC=0
100   CONTINUE
      ICC=ICC+1
      IF(ICC.GT.ICCMAX)GO TO 800
      QX=0.5*(QMAX+QMIN)
      CALL THY(IG,CLKE,QSO,HSO,TSO,VSO,HWX,QX,TWX,CDI,CHF,CWF,
     &         CLF,CIF,COF,HWC,VEC,TWVM)
CDIAG WRITE(6,210)QMAX,QMIN,QX,HWX,HWC
210   FORMAT(1X,3F12.5,2F15.3)
      IF(ABS(HWX-HWC).LT.CCTOL)GO TO 900
      IF(ABS(QMAX-QMIN).LT.0.005.AND.ABS(HWX-HWC).LT.0.1)GO TO 900
      IF(HWC.GT.HWX)QMAX=QX
      IF(HWC.LT.HWX)QMIN=QX
      GO TO 100
C
800   CONTINUE
      IF(ABS(HWX-HWC).GT.0.10)WRITE(6,810)ICCMAX,CCTOL,ABS(HWX-HWC)
810   FORMAT(1X,'WARNING 810: '
     &'THYSIS CULVERT FLOW DNC. CCTOL HWX-HWC',2X,I4,2X,F6.4,F9.4)
      QX=(QMAX+QMIN)/2.
C
900   CONTINUE
      QC=QX
      RETURN
      END
      SUBROUTINE THY(IG,CLKE,QSO,HSO,TSO,VSO,HWX,QX,TWX,CDI,CHF,CWF,
     &               CLF,CIF,COF,HWC,VEC,TWVM)
      CHARACTER*80 ACARD
      CHARACTER*80 ACARD1,ACARD2,ACARD3,ACARD4,ACARD5,ACARD6,ACARD7
      CHARACTER*20 VER,IDTME0                                           VAXPC
      CHARACTER*17 IDTME                                                VAXPC
      PARAMETER (VER='DOS- VER 2.4.2 1992')                             PC
      COMMON/TITLE/ IPAGE,IDTME                                         VAXPC
      DOUBLE PRECISION DFLBCM,D100                                      00066*26
      REAL ISTA(50)                                                     00067**7
      DIMENSION KVAL(495)                                               00068**7
      COMMON RBLCOM(2558),IBLCOM(101)                                   00069*25
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00070
     1NICOM1,NRCOM1,NICOM2,NRCOM2,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC, 00071
     2TWV
      COMMON/GPLOTS/GRNO,XSV,YSV,IPLOT                                  00072
C     GPLOTS IS THE COMMON BLOCK FOR PLOT RELATED VARIABLES             00073
C     GRNO IS A COUNTER TO NUMBER GRAPHS BY                             00074
C     IPLOT HAS 3 FUNCTIONS.  THEY ARE                                  00075
C          (1) FLAG TO SEE IF PLOTS HAS BEEN CALLED (IF NOT EQUAL TO 0) 00076
```

```
C          (2) FLAG TO TELL WHICH SUBSYSTEM PLOTTED LAST (BY NUMBER 1-5)00077
C          (3) FLAG FOR STACKING PLOTS (WHETHER + OR -)                 00078
      COMMON/FCOM/RFLBCM(300),IFLBCM(501)                               00079*26
      COMMON/F100/N100,R100A(5),D100(100),R100B(100)                    00080*26
      COMMON/CARD/ACARD,ACARD1,ACARD2,ACARD3,ACARD4,ACARD5,ACARD6,ACARD700081**7
      COMMON/HYFLG/ ISUMRY,NITM                                         00082*27
      COMMON/HYDAT/ SBUF                                                00083*27
C
      COMMON /SDPCHR/ INPFIL,OUTFIL                                     DOS*1
      COMMON /SDPCLN/ INPLEN,OUTLEN,ABORT                               DOS*1
      CHARACTER*60    INPFIL,OUTFIL                                     DOS*1
      INTEGER         INPLEN,OUTLEN,ABORT                               DOS*1
C
      CHARACTER*5 HIDRO,HIDRA,COLBRG,SUWER,POMP,DEBOG,UPDAT,FLD1A       00084**7
      CHARACTER*2 INDEX,COMMUN,TRMNAT,CNTNU,FLD2A,FLD3A,FLD4A,FLD5A     00085**7
      CHARACTER*6 FINISH                                                00086**7
      CHARACTER*80 SBUF(100)                                            00087*27
      EQUIVALENCE (KA(1),KVAL(1)),(ISTA(1),RBLCOM(2506))                00088
      DATA HIDRO,HIDRA,COLBRG,SUWER,POMP,DEBOG,INDEX,COMMUN,TRMNAT,     00089
     1 CNTNU,FINISH/'HYDRO','HYDRA',                                    00090**7
     2 'CULBR','SEWER','PUMP ','DEBUG','IN','CO','TE','CO',             00091**6
     3 'FINISH'/,LRCA,LICA,LRCB,LICB,LRLF,LILF/5,0,2553,101,300,501/,   00092*26
     4 UPDAT/'UPDAT'/                                                   00093*26
C
      IGATE=IG
      QSOFF=QSO
      HSOFF=HSO
      TWSOFF=TSO
      VWSOFF=VSO
      HWXC=HWX-CIF
      HWC=-99.
      VEC=-99.
      IF(QX.LE.0.01)RETURN
C
      WRITE(ACARD1,110)
110   FORMAT('CULBRG              ANALYSIS            ',
     .       'CULVERT   SINGLE                  99999')
      WRITE(ACARD2,120)QX,TWX
120   FORMAT('SUPPLY Q= ',F7.2,'   CFS       TW ELEV = ',
     .       F9.3,' FREQUENCY=   0 YRS       99999')
      IF(CDI.EQ.0.)GO TO 135
      WRITE(ACARD3,130)
130   FORMAT('CLVRT 999 CIRCULAR                      ',
     .       'CONCRETE                          99999')
      GO TO 139
135   CONTINUE
      WRITE(ACARD3,136)
136   FORMAT('CLVRT 999                       BOX       ',
     .       'CONCRETE                          99999')
139   CONTINUE
      WRITE(ACARD4,140)INT(CLKE*100.)
140   FORMAT('CLVRT 999 STRAIGHT                      ',
     .       '                   NORMAL KE=',I3.3,'  99999')
      WRITE(ACARD5,150)COF,CLF,CIF
150   FORMAT('CLVRT 999 OUTLT STA       0.  EL',F7.2,' ',
     .       'INLET STA',F9.2,'  EL',F7.2,'      99999')
      IF(CDI.EQ.0.)GO TO 165
```

```
      ICDIN=INT(CDI+0.5)
      WRITE(ACARD6,160)ICDIN
160   FORMAT('CLVRT 999 DIMENSIONS          DIAM=',I4,' ',
     .       'HIGH=     WIDE=       BARRELS=    199999')
      GO TO 169
165   CONTINUE
      WRITE(ACARD6,166)CHF,CWF
166   FORMAT('CLVRT 999 DIMENSIONS          DIAM=     ',
     .       'HIGH=',F4.1,' ','WIDE=',F4.1,'   BARRELS=    199999')
169   CONTINUE
      WRITE(ACARD7,170)
170   FORMAT('ENDATA                                  ',
     .       '                                   99999')
C
180   FORMAT(1X,A80)
181   FORMAT(I1)
C                                                                       00094**8
      IPLOT=0                                                           00100
C                                                                       VAX*1
      GRNO=0.0                                                          00101
      DO 252 I=1,LRLF                                                   00102
252   RFLBCM(I)=0.                                                      00103
      DO 253 I=1,LILF                                                   00104
253   IFLBCM(I)=0                                                       00105
      LRCS=LRCA+LRCB                                                    00106
      DO 248 I=1,LRCS                                                   00107
248   RBLCOM(I)=0.0                                                     00108
      DO 249 I=1,LICB                                                   00109
249   IBLCOM(I)=0                                                       00110
      KSYS=0                                                            00111
      DO 250 I=1,495                                                    00112
250   KVAL(I)=999                                                       00113
C                                                                       00114
300   CONTINUE
CDEL  READ(ACARD1,'(A80)',END=1299) ACARD                               00123**7
      ACARD = ACARD1
      READ (ACARD,50) FLD1A,FLD2A,FLD3A,FLD4A,FLD5A                     00124**7
 50   FORMAT (BZ,A,5X,2(A,8X),10X,2(A,8X))                              00125**7
CDEL  WRITE (SYSOUT,67) ACARD                                           00126**7
 67   FORMAT (1X,A80)                                                   00127**7
      GO TO 302                                                         00128
301   CONTINUE
      GO TO 1299                                                        00129*14
CDEL  READ(ACARD,50) FLD1A,FLD2A,FLD3A,FLD4A,FLD5A
CDEL  ACARD = ACARD1                                                    00130*13
CDEL  WRITE (SYSOUT,67) ACARD
302   CONTINUE
CDEL  IF(FLD1A.EQ.HIDRO)GO TO 303                                       00131
CDEL  IF(FLD1A.EQ.HIDRA)GO TO 304                                       00132
      IF(FLD1A.EQ.COLBRG)GO TO 305                                      00133
CDEL  IF(FLD1A.EQ.SUWER)GO TO 306                                       00134
CDEL  IF(FLD1A.EQ.POMP)GO TO 401                                        00135
CDEL  IF(FLD1A.EQ.DEBOG)GO TO 1101                                      00136
CDEL  IF (FLD1A.EQ.UPDAT) CALL UPDATE                                   00137*25
      GO TO 501                                                         00138
C                                                                       00139
C                                                                       00175
```

```
C      CULBRG CALL ROUTINE. KC VALUES INITIALIZED IN CULBRG             00176
C                                                                       00177
  305 IF(KSYS.EQ.2) GO TO 307                                           00178
      N100=0                                                            00179
      DO 706 I=1,5                                                      00180*26
  706  R100A(I) = 0.0                                                   00181*26
      DO 708 I=1,100                                                    00182*26
  708  D100(I) = 0.0                                                    00183*26
      DO 710 I=1,100                                                    00184*26
  710  R100B(I) = 0.0                                                   00185*26
  307 KSYS=3                                                            00186
      CALL CULBRG(HWC,VEC)                                              00187
      GO TO 301                                                         00188
C                                                                       00189
402   CONTINUE
CDEL  CALL PAGE                                                         00281*18
      IF(FLD5A.EQ.TRMNAT)GO TO 1299                                     00282
      IF(FLD4A.EQ.CNTNU)GO TO 403                                       00283
CDEL  WRITE(SYSOUT,3)                                                   00284
3     FORMAT(' NO INDICATION AS TO WHETHER TO CONTINUE OR TERMINATE--CON00285
     1TINUE ASSUMED')                                                   00286
403   IF(KSYS.EQ.0)GO TO 300                                            00287
406   CONTINUE
      GO TO 301                                                         00294
501   IF(ACARD(1:6).EQ.FINISH) GO TO 1299                               00299**7
      IF(ACARD(1:1).EQ.'$') GO TO 300                                   00300**7
CDEL  WRITE(SYSOUT,4)                                                   00301
4     FORMAT(' CARD NOT RECOGNIZED. INFORMATION IGNORED')               00302
      GO TO 403                                                         00303
1299  CONTINUE
9990  CONTINUE
      TWVM=TWV
      RETURN
      END                                                               00306
      SUBROUTINE CULBRG(HWC,VEC)                                        00001
C                                                                       00002
C     THE PURPOSE OF CULBRG IS TO PROVIDE DESIGN AND/OR ANALYSIS OF     00003
C     BRIDGE AND/OR CULVERT USING INFORMATION INPUT ON THESE FORMS,     00004
C     AND OBTAINED FROM HYDRO AND HYDRA                                 00005
C                                                                       00006
      CALL CULBRR(HWC,VEC,*1)                                           00007**3
      GO TO 2                                                           00008
1     CALL CULBRC(HWC,VEC)                                              00009
      CALL CULBR1(HWC,VEC,*1)                                           00011**3
2     RETURN                                                            00012
      END                                                               00013
      SUBROUTINE CULBRR(HWC,VEC,*)                                      00001
C
C  CULBRR READS RECORDS CONTAINING VARIABLES WHICH DESCRIBE CULVERTS    00003*33
C  IN TERMS OF MATERIALS, PROFILES, AND ENTRANCE CONFIGURATIONS         00004*33
C                                                                       00005*33
      DOUBLE PRECISION X100                                             00006*25
      DIMENSION RCLBCM(156),RFLBCM(300),IFLBCM(501),PRICE(92),ICK(10)   00007*31
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH,L     00008*25
      INTEGER SHAPE,PROFIL,OPENGS,B                                     00009*31
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),        00010
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00011*25
```

```
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00012
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00013
      COMMON/COSCOM/PRC(90),CONC,STL,FILLH,CMISC,COSFT,TOTCOS           00014
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00015*22
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00016*30
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00017*22
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00018*22
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00019*25
      COMMON/FCOM/HW(100),SL(100),V(100),B(100),H(100),IQP(100),        00020*25
     1 L(100),NUMCUL,W(100)                                             00021*25
      COMMON/F100/N100,CLREL,HEL,Q100,V100,WTL100,X100(100),Y100(100)   00022
      COMMON/GPLOTS/GRNO,XSV,YSV,IPLOT                                  00023*23
      CHARACTER*80 ACARD
      CHARACTER*80 ACARD1,ACARD2,ACARD3,ACARD4,ACARD5,ACARD6,ACARD7     00024*25
      COMMON/CARD/ACARD,ACARD1,ACARD2,ACARD3,ACARD4,ACARD5,ACARD6,ACARD700025*25
      CHARACTER*4 SHI,SWI,SDI                                           00026*32
      COMMON/FCOM1/JOBNO,JOBNOB,IN(100),IP(100),M(100),C(100),          00027*32
     *   S(100),SHI(100),SWI(100),SDI(100)                              00028*32
      COMMON/RCOM1/SMAN(100),SKEC(100),SMHW(100)                        00029*32
      COMMON/CCOM1/BRSUB(10),CLVTID,FLSEC,NAME,ORIGID,ROADID            00030*25
      EQUIVALENCE  (BBLS,RCLBCM(1)),(HW(1),                             00031*25
     1 RFLBCM(1)),(B(1),IFLBCM(1)),(PRICE(1),PRC(1)),(PRICE(91),CONC),  00032
     2 (PRICE(92),STL)                                                  00033
      CHARACTER*1 COMNT,A0101,BRKBK,ATSIN                               00034*32
      CHARACTER*2 A2BLNK,DESIGN,ANLS,BRIDGE,CUL,SINGLE,SUPPLY,CLVRT,    00035*25
     1 ROAD,FLDV,JOB,ENDATA,CIRC,STRT,OUTLT,BREAK,MAX,DIMEN,CONCRT,     00036*25
     2 CGMP,PLATE,FLARED,DROP,NORMAL,ARCH,OVAL,BOX,STEPED,LEFT,         00037*25
     3 UP,DN,PLAN,TW,COST,PIP,FIL,CMIS,STATE,FRQ,RD,A1112,A2122,        00038*25
     4 A3132,A4142,A5152,A0102,A6162,A2627,A5960,JOB1,JOBNOB,DUM        00039*32
      CHARACTER*3 A3BLNK,A7173,CLVTID,A0709,BRSUB,NAME,ROADID,C         00040*25
      CHARACTER*4 A4BLNK,FINISH,ORIGID,FLSEC,A3639,A6164,A4649,A5659,   00041*25
     1 A7275,S,A1619,TEMP3                                              00042*31
      CHARACTER*5 A5BLNK,A7175                                          00043*25
      CHARACTER*6 A6BLNK,A1116,IN                                       00044*25
      CHARACTER*7 A7BLNK,A4854,A3339,A6369,A3137,A6167,CMXHW            00045*32
      CHARACTER*8 A8BLNK,IPRFL2,A4148,A1219,A2229,A3239,A4249,A5259,    00046*25
     1 A6269,A2128,A5158,A6168,NJOB,A0310,JOBNO,DUMMY,M,IP,A3138        00047*32
      DATA A2BLNK,A3BLNK,A4BLNK,A5BLNK,A6BLNK,A7BLNK,A8BLNK,            00048
     1 DESIGN,ANLS,BRIDGE,CUL,   SINGLE,SUPPLY,CLVRT,ROAD,FLDV,JOB,     00049
     2 ENDATA,COMNT,CIRC,STRT,OUTLT,BREAK,MAX,DIMEN,CONCRT,CGMP,PLATE,  00050
     3 FLARED,DROP,NORMAL,ARCH,OVAL,BOX,STEPED,LEFT,UP,DN/              00051
     4 '  ','   ','    ','     ','      ','       ','        ','DE',    00052
     5'AN','BR','CU','SI','SU','CL','RO','FL','JO','EN','$','CI','ST',  00053
     6 'OU','BR','MA','DI','CO','CG','PL','FL','DR','NO','AR','OV',     00054
     7 'BO','ST','LE','UP','DN'/,IPRFL2,PLAN,TW,COST,PIP,FIL,CMIS,STATE,00055
     8 FINISH/'BROKN BK','PL','TW','CO','PI','FI','MI','ST','NISH'/,    00056
     9 FRQ,RD,ATSIN/'FR','RD','@'/                                      00057*32
      DATA DUMMY,DUM/'   DUMMY','DM'/                                   00058*32
      KA(99)=3                                                          00059
      LRLC=156                                                          00060*30
      LILC=20                                                           00061
      LRLF = 300                                                        00062*25
      LILF = 501                                                        00063*25
      IF (KC(99).NE.999) GO TO 100                                      00064
      DO 93 I=1,92                                                      00065
   93 PRICE(I)=9999999.                                                 00066
      FILLH=0.                                                          00067
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      COSFT=0.                                                          00068
100   DO 90 I=1,LRLC                                                    00069
C              INITIALIZE COMMON BLOCKS                                 00070*18
90    RCLBCM(I)=0.0                                                     00071
      DO 91 I=1,10                                                      00072*25
   91 BRSUB(I) = A3BLNK                                                 00073*25
      CLVTID = A3BLNK                                                   00074*25
      FLSEC = A4BLNK                                                    00075*25
      INLET = 0                                                         00076*25
      MAT = 0                                                           00077*25
      NAME = A3BLNK                                                     00078*25
      OPENGS = 0                                                        00079*25
      ORIGID = A4BLNK                                                   00080*25
      PROFIL = 0                                                        00081*25
      ROADID = A3BLNK                                                   00082*25
      SHAPE = 0                                                         00083*25
      CLREL=-1000.0                                                     00084
      CMISC=0.                                                          00085
      TOTCOS=0.                                                         00086
      READ(A4BLNK,FMT='(A4)') RBLNK                                     00087*30
      MAXHW=RBLNK                                                       00088*30
      OUTSTA=RBLNK                                                      00089*30
      OUTEL=RBLNK                                                       00090*30
      INSTA=RBLNK                                                       00091*30
      INEL=RBLNK                                                        00092*30
      JOBNO=DUMMY                                                       00093*32
      JOBNOB=DUM                                                        00094*32
      KC65=KC(65)                                                       00095
      DO 92 I=1,99                                                      00096
92    KC(I)=0                                                           00097
      DO 99 I=1,10                                                      00098*21
   99 ICK(I)=0                                                          00099*21
      IF (KC65.NE.999) KC(65)=KC65                                      00100
C
      IAC=1
      ACARD=ACARD1
C                                                                       00101
C     DECODE CULBRG                                                     00102
C                                                                       00103
      READ (ACARD,55) A1112,A2122,A3132,A4142,A5152,A7173               00104*25
   55 FORMAT(BZ,10X,5(A,8X),10X,A)                                      00105*25
CDEL  WRITE (SYSOUT,178) ACARD
      IF (A1112.NE.DESIGN) GO TO 101                                    00106*21
      KC(1)=1                                                           00107
      GO TO 103                                                         00108
101   IF (A2122.NE.ANLS) GO TO 102                                      00109*21
      KC(2)=1                                                           00110
      GO TO 103                                                         00111
102   CONTINUE
CDEL  WRITE (SYSOUT,1)                                                  00112
1     FORMAT (  48H CLB0001--NEITHER DESIGN NOR ANALYSIS SPECIFIED.  )  00113*20
      KC(98)=1                                                          00114
103   IF (A4142.NE.CUL)    GO TO 107                                    00115*21
      IF (A5152.NE.SINGLE) GO TO 104                                    00116*21
      KC(4)=1                                                           00117
      OPENGS=1                                                          00118
      IF (A3132.EQ.BRIDGE) KC(3)=1                                      00119*21
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```
      GO TO 210                                                         00120
104   CONTINUE
CDEL  WRITE (SYSOUT,52)                                                 00121
52    FORMAT (  79H CLB0002--ROUTINE NOT AVAILABLE TO DESIGN OR ANALYZE 00122*20
     $MULTIPLE OPENING CULVERTS.  )                                     00123*20
      IF (A3132.EQ.BRIDGE) GO TO 105                                    00124*21
      GO TO 106                                                         00125
107   IF (A3132.EQ.BRIDGE) GO TO 105                                    00126*21
CDEL  WRITE (SYSOUT,2)                                                  00127
2     FORMAT (  47H CLB0003--NEITHER BRIDGE NOR CULVERT SPECIFIED.  )   00128*20
106   KC(98)=1                                                          00129
      GO TO 210                                                         00130
105   KC(3)=1                                                           00131
      IF (A5152.NE.SINGLE) GO TO 108                                    00132*21
      OPENGS=1                                                          00133
      GO TO 210                                                         00134
108   IF (A7173.EQ.A3BLNK) GO TO 109                                    00135*21
      READ (ACARD,56) OPENGS                                            00136*25
56    FORMAT (BZ,70X,I3)                                                00137
      GO TO 210                                                         00138
109   CONTINUE
CDEL  WRITE (SYSOUT,3)                                                  00139
3     FORMAT (  43H CLB0004--NUMBER OF OPENINGS NOT SPECIFIED.    )     00140*20
      GO TO 106                                                         00141
C                                                                       00142
C     CHECK HYDRO AND HYDRA AND READ CULBRG CARDS                       00143
C                                                                       00144
210   IF (QPEAK.EQ.0.0) GO TO 200                                       00145
      IF (FREQ.NE.0.0) GO TO 200                                        00146
CDEL  WRITE (SYSOUT,6)                                                  00147
6     FORMAT (  29H CLB0005--NO FREQUENCY GIVEN.   )                    00148*20
      GO TO 200                                                         00149
C                                                                       00150
C     READ DATA CARDS AND DECODE SUPPLY Q CARD                          00151
C                                                                       00152
      ENTRY CULBR1(HWC,VEC,*)                                                   00153
      IF(KC(31).NE.1.OR.SHAPE.NE.4) GO TO 200                           00154*30
      HIGH=HIGH/12.                                                     00155*30
      WIDE=WIDE/12.                                                     00156*30
  200 CONTINUE
      IAC=IAC+1
      IF(IAC.EQ.2)ACARD=ACARD2
      IF(IAC.EQ.3)ACARD=ACARD3
      IF(IAC.EQ.4)ACARD=ACARD4
      IF(IAC.EQ.5)ACARD=ACARD5
      IF(IAC.EQ.6)ACARD=ACARD6
      IF(IAC.EQ.7)ACARD=ACARD7
      IF(IAC.GT.7)GO TO 9999
CDEL  READ (SYSIN,FMT='(A80)',END=9999) ACARD                           00157*25
      READ (ACARD,57) A0102,A1116,A3132,A4148,A6164                     00158*25
   57 FORMAT (BZ,A,8X,A,14X,A,8X,A,12X,A)                               00159*25
CDEL  WRITE (SYSOUT,178) ACARD                                          00160*25
  178 FORMAT(1X,A)                                                      00161*25
      READ (ACARD,95) A0101                                             00162*25
   95 FORMAT(BZ,A)                                                      00163*25
      IF (A0101.EQ.COMNT) GO TO 200                                     00164*21
      IF ( A0102 .NE. CUL ) GO TO 98                                    00165*21
```

```
      Q100 = 0.0                                                        00166*18
C                        RESET DISCHARGE AND TAILWATER.                 00167*18
      WTL100 = 0.0                                                      00168*18
      GO TO 100                                                         00169*18
98    IF ( A0102 .EQ. SUPPLY ) GO TO 310                                00170*21
      IF (A3132.EQ.TW) GO TO 308                                        00171*21
      IF(A0102.EQ.FRQ) GO TO 312                                        00172*21
      IF(A0102.EQ.RD) GO TO 314                                         00173*21
      GO TO 400                                                         00174
310   IF (A1116.NE.A6BLNK) GO TO 301                                    00175*21
      IF (QPEAK.NE.0.0) GO TO 302                                       00176
CDEL  WRITE (SYSOUT,4)                                                  00177
4     FORMAT (  36H CLB0006--NO Q SUPPLIED OR COMPUTED.  )              00178*20
303   KC(98)=2                                                          00179
      GO TO 200                                                         00180
  301 READ (ACARD,58) QPEAK                                             00181*25
58    FORMAT (BZ,10X,F6.0)                                              00182
      GO TO 308                                                         00183
302   CONTINUE
CDEL  WRITE (SYSOUT,580)                                                00184
580   FORMAT (  50H CLB0007--NO SUPPLY Q GIVEN.  PREVIOUS VALUE USED.  )00185*20
308   IF (A4148 .NE.A8BLNK) GO TO 304                                   00186*21
      IF (KB(99).EQ.1) GO TO 305                                        00187
CDEL  WRITE (SYSOUT,5)                                                  00188
5     FORMAT (  39H CLB0008--NO TAILWATER ELEVATION GIVEN.   )          00189*20
      IF (KC(3).EQ.1) GO TO 303                                         00190
      GO TO 311                                                         00191
  304 READ (ACARD,59) WATEL                                             00192*25
      KB(97)=0                                                          00193
59    FORMAT (BZ,40X,F8.0)                                              00194
      GO TO 309                                                         00195
305   CONTINUE
CDEL  WRITE (SYSOUT,590)                                                00196
590   FORMAT (  61H CLB0009--NO TAILWATER ELEVATION GIVEN.  PREVIOUS VAL00197*20
     $UE USED.  )                                                       00198*20
      GO TO 309                                                         00199
311   WATEL=0.0                                                         00200
309   IF (A6164 .NE.A4BLNK) GO TO 306                                   00201*21
      IF (FREQ.NE.0.0) GO TO 307                                        00202
CDEL  WRITE (SYSOUT,6)                                                  00203
      GO TO 200                                                         00204
307   CONTINUE
CDLE  WRITE (SYSOUT,6000)                                               00205
6000  FORMAT (  51H CLB0010--NO FREQUENCY GIVEN.  PREVIOUS VALUE USED. )00206*20
      GO TO 200                                                         00207
  306 READ (ACARD,60) FREQ                                              00208*25
60    FORMAT (BZ,62X,F2.0)                                              00209
      GO TO 200                                                         00210
  312 READ (ACARD,81) F1318,F2834,A4854                                 00211*25
   81 FORMAT (BZ,12X,F6.0,9X,F7.0,13X,A)                                00212*25
      IF(F1318.GT.0.01) Q100=F1318                                      00213*21
      IF(F2834.GT.0.01) WTL100=F2834                                    00214*21
      IF (A4854.NE.A7BLNK)  READ(ACARD,97) CLREL                        00215*25
   97 FORMAT(BZ,47X,F7.0)                                               00216
      GO TO 200                                                         00217
 314  IF(KC(44).EQ.1) GO TO 315                                        00218
      KC(44)=1                                                          00219
```

```
      N100=0                                                            00220
  315 READ (ACARD,86) A1219,A2229,A3239,A4249,A5259,A6269               00221*25
   86 FORMAT (BZ,9X,6(2X,A))                                            00222*25
      IF(A1219.NE.A8BLNK) GO TO 316                                     00223*21
CDEL  WRITE(SYSOUT,22)                                                  00224
22    FORMAT ( 55H CLB0011--NO INITIAL COORDINATE.  REST OF CARD IGNORED00225*20
     $.)                                                                00226*20
      GO TO 200                                                         00227
 316  IF(A2229.NE.A8BLNK) GO TO 318                                     00228*21
 317  CONTINUE
CDEL  WRITE(SYSOUT,23)                                                  00229
23    FORMAT (  67H CLB0012--Y COORDINATE MISSING.  THIS SET AND REST OF00230*20
     $ CARD IGNORED.  )                                                 00231*20
      GO TO 200                                                         00232
 318  IF(N100.LT.100) GO TO 320                                         00233
 319  CONTINUE
CDEL  WRITE(SYSOUT,24)                                                  00234
24    FORMAT (  73H CLB0013--TOO MANY POINTS DESCRIBING ROAD PROFILE.  P00235*20
     $RESENT LIMIT IS 100. )                                            00236*20
      KC(98)=15                                                         00237
      GO TO 200                                                         00238
 320  N100=N100+1                                                       00239
      READ (ACARD,87) X100(N100),Y100(N100)                             00240*25
 87   FORMAT(BZ,11X,D8.0,2X,F8.0)                                       00241
      IF(A3239.EQ.A8BLNK) GO TO 200                                     00242*21
      IF(A4249.EQ.A8BLNK) GO TO 317                                     00243*21
      IF(N100.GE.100) GO TO 319                                         00244
      N100=N100+1                                                       00245
      READ (ACARD,88) X100(N100),Y100(N100)                             00246*25
 88   FORMAT(BZ,31X,D8.0,2X,F8.0)                                       00247
      IF(A5259.EQ.A8BLNK) GO TO 200                                     00248*21
      IF(A6269.EQ.A8BLNK) GO TO 317                                     00249*21
      IF(N100.GE.100) GO TO 319                                         00250
      N100=N100+1                                                       00251
      READ (ACARD,89) X100(N100),Y100(N100)                             00252*25
 89   FORMAT(BZ,51X,D8.0,2X,F8.0)                                       00253
      GO TO 200                                                         00254
C                                                                       00255
C     DECODE CULVERT CIRCULAR                                           00256
C                                                                       00257
400   IF (A0102.EQ.CLVRT) GO TO 401                                     00258*21
      IF (A0102.EQ.ROAD) GO TO 1100                                     00259*21
      IF (A0102.EQ.BRIDGE) GO TO 1200                                   00260*21
      IF (A0102.EQ.COST) GO TO 1700                                     00261*21
      IF (A0102.EQ.BOX) GO TO 1710                                      00262*21
      IF (A0102.EQ.PIP) GO TO 1800                                      00263*21
      IF (A0102.EQ.FIL) GO TO 1810                                      00264*21
      IF (A0102.EQ.CMIS) GO TO 1820                                     00265*21
      GO TO 1400                                                        00266
  401 READ (ACARD,85) CLVTID,A1112                                      00267*25
   85 FORMAT (BZ,6X,A,1X,A)                                             00268*25
      IF (A1112.EQ.CIRC) GO TO 402                                      00269*21
      IF (A1112.EQ.STRT) GO TO 500                                      00270*21
      IF (A1112.EQ.OUTLT) GO TO 600                                     00271*21
      IF (A1112.EQ.BREAK) GO TO 800                                     00272*21
      IF (A1112.EQ.MAX) GO TO 900                                       00273*21
      GO TO 700                                                         00274
```

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402   SHAPE=1                                                            00275
  403 MAT=0                                                              00276*19
      READ (ACARD,61) A4142,A5152,A6162,A7175                            00277*25
   61 FORMAT (BZ,40X,3(A,8X),A)                                          00278*25
      IF (A4142.NE.CONCRT) GO TO 404                                     00279*21
      MANN=1.0                                                           00280
      MAT=1                                                              00281
      GO TO 200                                                          00282
404   IF (A5152.NE.CGMP) GO TO 405                                       00283*21
      MAT=2                                                              00284
      MANN=2.0                                                           00285
      GO TO 200                                                          00286
405   IF (A6162.NE.PLATE) GO TO 406                                      00287*21
      MAT=3                                                              00288
      IF (A7175 .NE.A5BLNK.AND.SHAPE.EQ.2) GO TO 407                     00289*21
      MANN=3.0                                                           00290
      GO TO 200                                                          00291
406   IF (A7175 .NE.A5BLNK) GO TO 407                                    00292*21
CDEL  WRITE (SYSOUT,7)                                                   00293
7     FORMAT (  45H CLB0014--NO 'N' VALUE SPECIFIED OR SUPPLIED.  )      00294*20
      KC(98)=3                                                           00295
      GO TO 200                                                          00296
  407 READ (ACARD,62) MANN                                               00297*25
62    FORMAT (BZ,70X,F5.4)                                               00298
      GO TO 200                                                          00299
C                                                                        00300
C     DECODE CULVERT STRAIGHT CARD                                       00301
C                                                                        00302
500   PROFIL=1                                                           00303
  501 READ (ACARD,61) A4142,A5152,A6162,A7175                            00304*25
      IF (A4142.NE.FLARED) GO TO 502                                     00305*21
      INLET=1                                                            00306
      GO TO 200                                                          00307
502   IF (A5152.NE.DROP) GO TO 504                                       00308*21
      INLET=2                                                            00309
      IF (A7175 .NE.A5BLNK) GO TO 503                                    00310*21
      KECF=1.0                                                           00311
C                                                                        00312
C     ARB. VALUE FOR KECF - BV THD                                       00313
C                                                                        00314
      GO TO 200                                                          00315
  503 READ (ACARD,62) KECF                                               00316*25
      GO TO 200                                                          00317
504   IF (A6162.NE.NORMAL) GO TO 505                                     00318*21
      INLET = 3                                                          00319
      IF (A7175 .NE.A5BLNK) GO TO 506                                    00320*21
CDEL  WRITE (SYSOUT,8)                                                   00321
8     FORMAT (  46H CLB0015--NO 'KE' VALUE SPECIFIED OR SUPPLIED. )      00322*20
      KC(98)=5                                                           00323
      GO TO 200                                                          00324
  506 READ (ACARD,62) KECF                                               00325*25
      GO TO 200                                                          00326
505   CONTINUE
CDEL  WRITE (SYSOUT,9)                                                   00327
9     FORMAT (  49H CLB0016--TYPE OF INLET CONDITIONS NOT SPECIFIED. )   00328*20
      KC(98)=5                                                           00329
      GO TO 200                                                          00330
```

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C                                                                       00331
C     DECODE CLVRT OUTLT CARD                                           00332
C                                                                       00333
  600 READ (ACARD,63) A2128,A3339,A5158,A6369                           00334*25
   63 FORMAT(BZ,20X,A,4X,A,11X,A,4X,A)                                  00335*25
      IF (A2128.NE.A8BLNK) GO TO 601                                    00336*21
CDEL  WRITE (SYSOUT,10)                                                 00337
10    FORMAT (  55H CLB0017--CULVERT STATIONING AND ELEVATIONS INCOMPLET00338*20
     $E.    )                                                           00339*20
      KC(98)=6                                                          00340
      GO TO 602                                                         00341
  601 READ (ACARD,64) OUTSTA                                            00342*25
64    FORMAT (BZ,20X,F8.0)                                              00343
  602 IF (A3339.NE.A7BLNK) GO TO 603                                    00344*25
CDEL  WRITE (SYSOUT,10)                                                 00345
      KC(98)=6                                                          00346
      GO TO 604                                                         00347
  603 READ (ACARD,65) OUTEL                                             00348*25
65    FORMAT (BZ,32X,F7.0)                                              00349
  604 IF (A5158.NE.A8BLNK) GO TO 605                                    00350*25
CDEL  WRITE (SYSOUT,10)                                                 00351
      KC(98)=6                                                          00352
      GO TO 606                                                         00353
  605 READ (ACARD,66) INSTA                                             00354*25
66    FORMAT (BZ,50X,F8.0)                                              00355
606   IF (A6369 .NE.A7BLNK) GO TO 607                                   00356*21
CDEL  WRITE (SYSOUT,10)                                                 00357
      KC(98)=6                                                          00358
      GO TO 200                                                         00359
  607 READ (ACARD,67) INEL                                              00360*25
67    FORMAT (BZ,62X,F7.0)                                              00361
      GO TO 200                                                         00362
C                                                                       00363
C     MORE DECODE- CLVRT CIRCULAR AND STRAIGHT                          00364
C                                                                       00365
  700 READ (ACARD,68) A1112,A2122,A2627,A3132,A4142,A7175               00366*25
   68 FORMAT (BZ,10X,A,8X,2(A,3X),A,8X,A,28X,A)                         00367*25
      IF (A1112.EQ.DIMEN) GO TO 1000                                    00368*21
      IF (A2122.NE.ARCH) GO TO 701                                      00369*21
      SHAPE=2                                                           00370
      GO TO 403                                                         00371
701   IF (A2627.NE.OVAL) GO TO 702                                      00372*21
      SHAPE=3                                                           00373
      GO TO 403                                                         00374
702   IF (A2122.NE.BREAK) GO TO 703                                     00375*21
      PROFIL=2                                                          00376
      GO TO 501                                                         00377
703   IF (A3132.NE.BOX) GO TO 704                                       00378*21
      SHAPE=4                                                           00379
      MAT=0                                                             00380*19
      IF(A4142.NE.CONCRT) GO TO 707                                     00381*21
      MANN=1.0                                                          00382*19
      MAT=1                                                             00383*19
      GO TO 200                                                         00384*19
707   IF (A7175 .EQ.A5BLNK) GO TO 706                                   00385*21
      READ (ACARD,62) MANN                                              00386*25
      GO TO 200                                                         00387
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706   MANN=1.0                                                          00388
      GO TO 200                                                         00389
704   IF (A3132.NE.STEPED) GO TO 705                                    00390*21
      PROFIL=3                                                          00391
      GO TO 501                                                         00392
705   CONTINUE
CDEL  WRITE (SYSOUT,11)                                                 00393
11    FORMAT (  43H CLB0018--CLVRT CARD READ BUT DATA MISSING.  )       00394*20
      GO TO 200                                                         00395
C                                                                       00396
C     DECODE CLVRT BREAK                                                00397
C                                                                       00398
  800 READ (ACARD,63) A2128,A3339,A5158,A6369                           00399*25
      IF (KC(33).EQ.1) KC(5)=0                                          00400
      KC(33)=0                                                          00401
      IF (A2128.NE.A8BLNK) GO TO 801                                    00402*21
      IF (A3339.EQ.A7BLNK) GO TO 803                                    00403*21
802   CONTINUE
CDEL  WRITE (SYSOUT,12)                                                 00404
12    FORMAT (  57H CLB0019--BREAK STATIONING AND ELEVATION DATA INCOMPL00405*20
     $ETE. )                                                            00406*20
      KC(98)=8                                                          00407
      GO TO 200                                                         00408
801   IF (A3339.EQ.A7BLNK) GO TO 802                                    00409*21
      KC(5)=KC(5)+1                                                     00410
      I=KC(5)                                                           00411
      READ (ACARD,64) BRSTA(I)                                          00412*25
      READ (ACARD,65) BREL(I)                                           00413*25
803   IF (A5158 .NE.A8BLNK) GO TO 804                                   00414*21
      IF(A6369 .NE.A7BLNK)GO TO 802                                     00415*21
      GO TO 200                                                         00416
804   IF (A6369 .EQ.A7BLNK) GO TO 802                                   00417*21
      KC(5)=KC(5)+1                                                     00418
      I=KC(5)                                                           00419
      READ (ACARD,66) BRSTA(I)                                          00420*25
      READ (ACARD,67) BREL(I)                                           00421*25
      GO TO 200                                                         00422
C                                                                       00423
C     DECODE CLVRT MAX                                                  00424
C                                                                       00425
  900 READ (ACARD,69) A3137,A6167                                       00426*25
   69 FORMAT (BZ,30X,A,23X,A)                                           00427*25
      IF (A3137 .NE.A7BLNK) GO TO 901                                   00428*21
CDEL  WRITE (SYSOUT,13)                                                 00429
13    FORMAT (  40H CLB0020--MAXIMUM H. W. ELEV. NOT GIVEN. )           00430*20
      KC(98)=9                                                          00431
      GO TO 902                                                         00432
  901 READ (ACARD,70) MAXHW                                             00433*25
70    FORMAT (BZ,30X,F7.0)                                              00434
902   IF (A6167 .NE.A7BLNK) GO TO 903                                   00435*21
CDEL  WRITE (SYSOUT,14)                                                 00436
14    FORMAT (  58H CLB0021--MAX. OUTLET VELOC. NOT GIVEN.  VALUE SET AT00437*20
     $ 8.0.  )                                                          00438*20
      VMAX=8.0                                                          00439
C                                                                       00440
C     ARB. VALUE FOR VMAX BY THD                                        00441
C                                                                       00442
```

```
      GO TO 200
  903 READ (ACARD,71) VMAX
71    FORMAT (BZ,60X,F7.0)
      GO TO 200
C
C     DECODE CLVRT DIMENSIONS
C
 1000 READ (ACARD,72) A3639,A4649,A5659,A7175
   72 FORMAT (BZ,35X,A,2(6X,A),11X,A)
      KC(31)=1
      IF (A3639.NE.A4BLNK) GO TO 1003
      IF (A4649.NE.A4BLNK) GO TO 1002
1001  CONTINUE
CDEL  WRITE (SYSOUT,15)
15    FORMAT (  37H CLB0022--CULVERT DIMENSIONS MISSING.  )
      KC(98)=10
      GO TO 1004
1002  IF (A5659.EQ.A4BLNK) GO TO 1001
      READ (ACARD,73) HIGH,WIDE
73    FORMAT (BZ,45X,F4.0,6X,F4.0)
      GO TO 1004
 1003 READ (ACARD,74) DIAM
74    FORMAT (BZ,35X,F4.0)
      DIFT=DIAM/12.
1004  IF (A7175 .EQ.A5BLNK)GO TO 1005
      READ (ACARD,96) BBLS
96    FORMAT (BZ,70X,F5.0)
      GO TO 200
1005  BBLS=1.0
      GO TO 200
C
C     DECODE ROAD CARD
C
 1100 READ (ACARD,75) A0709,A2128,A4148,A6168
   75 FORMAT (BZ,6X,A,11X,A,12X,A,12X,A)
      IF (A0709.NE.A3BLNK) GO TO 1101
CDEL  WRITE (SYSOUT,16)
16    FORMAT (  43H CLB0023--NO ROAD CROSS-SECTION I.D. GIVEN.  )
      GO TO 1102
 1101 READ (ACARD,83) ROADID
   83 FORMAT (BZ,6X,A)
1102  IF (A2128.NE.A8BLNK) GO TO 1103
      UPSS=3.0
CDEL  WRITE(SYSOUT,560)UPSS
560   FORMAT (  36H CLB0024--NO SLOPE GIVEN.  VALUE OF , F4.1,
     $  9H ASSUMED.   )
      GO TO 1104
C
C     ARB. VALUE FOR UPSS - THD
C
 1103 READ (ACARD,64) UPSS
1104  IF (A4148 .NE.A8BLNK) GO TO 1105
      DNSS=3.0
CDEL  WRITE(SYSOUT,560)DNSS
C
C     ARB VALUE FOR DNSS - THD
C
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      GO TO 1106                                                        00499
 1105 READ (ACARD,59) DNSS                                              00500*25
1106  IF (A6168.NE.A8BLNK) GO TO 1107                                   00501*21
CDEL  WRITE (SYSOUT,17)                                                 00502
17    FORMAT (  55H CLB0025--NO MAX BARREL DEPTH GIVEN FOR CULVERT DESIG00503*20
     $N. )                                                              00504*20
      KC(98)=11                                                         00505
      GO TO 200                                                         00506
 1107 READ (ACARD,76) DEPTH                                             00507*25
76    FORMAT (BZ,60X,F8.0)                                              00508
      GO TO 200                                                         00509
C                                                                       00510
C     SELECT TYPE OF BRIDGE CARD AND DECODE BRDG MAX                    00511
C                                                                       00512
 1200 READ (ACARD,77) A0709,A1112,A3137,A6167                           00513*25
   77 FORMAT (BZ,6X,A,1X,A,18X,A,23X,A)                                 00514*25
      IF (A0709.NE.A3BLNK) GO TO 1201                                   00515*21
CDEL  WRITE (SYSOUT,18)                                                 00516
18    FORMAT (  51H CLB0026--BRIDGE SUBSECTION IDENTIFICATION MISSING. )00517*20
      KC(98)=12                                                         00518
      GO TO 200                                                         00519
 1201 READ (ACARD,83) NAME                                              00520*25
      II=KC(6)+1                                                        00521
      DO 1202 J=1,II                                                    00522
       I=J                                                              00523
       IF (NAME.EQ.BRSUB(I)) GO TO 1203                                 00524
1202  CONTINUE                                                          00525
      KC(6)=I                                                           00526
      BRSUB(I)=NAME                                                     00527
1203  IF (A1112.EQ.MAX) GO TO 1204                                      00528*21
      IF (A1112.EQ.LEFT) GO TO 1300                                     00529*21
CDEL  WRITE (SYSOUT,19)                                                 00530
19    FORMAT (  38H CLB0027--UNIDENTIFIED BRDG CARD READ. )             00531*20
      GO TO 200                                                         00532
1204  IF (A3137 .NE.A7BLNK) GO TO 1205                                  00533*21
      VMAXB(I)=6.0                                                      00534
CDEL  WRITE(SYSOUT,570)VMAXB(I)                                         00535
570   FORMAT (  38H CLB0028--NO MAXIMUM VELOCITY GIVEN.  , F4.1,        00536*20
     $  9H ASSUMED.   )                                                 00537*20
C                                                                       00538
C     ARB. VALUE FOR VMAX - THD                                         00539
C                                                                       00540
      GO TO 1206                                                        00541
 1205 READ (ACARD,70) VMAXB(I)                                          00542*25
1206  IF (A6167 .NE.A7BLNK) GO TO 1207                                  00543*21
      VMIN(I)=4.0                                                       00544
CDEL  WRITE(SYSOUT,571)VMIN(I)                                          00545
571   FORMAT (  38H CLB0029--NO MINIMUM VELOCITY GIVEN.  , F4.1,        00546*20
     $  9H ASSUMED.   )                                                 00547*20
      GO TO 1208                                                        00548*24
C                                                                       00549
C     ARB  VALUE FOR VMIN - THD                                         00550
C                                                                       00551
 1207 READ (ACARD,71) VMIN(I)                                           00552*25
1208  ICK(I)=ICK(I)+1                                                   00553*24
      GO TO 200                                                         00554
C                                                                       00555
```

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C     DECODE BRDG LEFT                                                  00556
C                                                                       00557
 1300 READ (ACARD,78) A2128,A4148,A5960,A7275                           00558*25
   78 FORMAT (BZ,20X,A,12X,A,10X,A,11X,A)                               00559*25
      KC(8)=1                                                           00560
      IF (A2128.NE.A8BLNK) GO TO 1302                                   00561*21
1301  CONTINUE
CDEL  WRITE (SYSOUT,20)                                                 00562
20    FORMAT (  43H CLB0030--BRIDGE HEADER SLOPE DATA MISSING.   )      00563*20
      KC(98)=13                                                         00564
      GO TO 200                                                         00565
1302  IF (A4148 .EQ.A8BLNK) GO TO 1301                                  00566*21
      ICK(I)=ICK(I)+2                                                   00567*21
      IF (A5960.EQ.UP) GO TO 1303                                       00568*21
      IF (A5960.NE.DN) GO TO 1301                                       00569*21
      READ (ACARD,64) LFTSS(I)                                          00570*25
      READ (ACARD,59) RGTSS(I)                                          00571*25
      GO TO 1304                                                        00572
 1303 READ (ACARD,64) RGTSS(I)                                          00573*25
      READ (ACARD,59) LFTSS(I)                                          00574*25
1304  IF (A7275.EQ.A4BLNK) GO TO 200                                    00575*21
      READ (ACARD,94) ORIGID                                            00576*25
   94 FORMAT (BZ,71X,A)                                                 00577*25
      GO TO 200                                                         00578
C                                                                       00579
C     DECODE JOBNO, ENDATA, COMNT, AND RETURN TO SYSTEM                 00580
C                                                                       00581
1400  IF (A0102.EQ.FLDV) GO TO 1500                                     00582*21
      IF (A0102.NE.JOB) GO TO 1402                                      00583*21
      READ (ACARD,79) JOBNOB,JOBNO                                      00584*30
   79 FORMAT (BZ,10X,A,A)                                               00585*25
      JOB1=JOBNOB                                                       00586*30
      NJOB=JOBNO                                                        00587*30
      GO TO 200                                                         00588
1402  IF (A0102.EQ.ENDATA) GO TO 1600                                   00589*21
      READ (ACARD,80) A0310                                             00590*25
   80 FORMAT (BZ,2X,A)                                                  00591*25
      IF (A0102.NE.A2BLNK.OR.A0310.NE.A8BLNK) GO TO 1404                00592*21
CDEL  WRITE (SYSOUT,25)                                                 00593
25    FORMAT (  30H CLB0031--PROBABLE BLANK CARD. )                     00594*20
      GO TO 200                                                         00595
1404  IF (A0102.NE.PLAN)   GO TO 1405                                   00596*21
      IF(NUMCUL.EQ.0)GO TO 1405                                         00597
CDEL  CALL PAGE                                                         00598*27
CDEL  WRITE (SYSOUT,48) JOB1,NJOB                                       00599*30
  48  FORMAT(//' SUMMARY OF CULVERT DESIGN/ANALYSIS'//1X,'JOB NO. ',    00600*27
     1 A2,A8//)                                                         00601*27
CDEL  WRITE (SYSOUT,4801)                                               00602
4801  FORMAT(' CLVRT  BBL',45X,'ENTRANCE',15X,'Q       ALLOW   CALC',   00603*32
     13X,'CALC'/' I.D.  SHAPE  BBLS   DIAM  WIDE  HIGH  LENGTH',2X,     00604*32
     2'''N'' VAL',2X,'COEF(KE)   SLOPE     (CFS)       HW     HW  ',    00605*32
     3 '  VELOC'/)                                                      00606*32
      LC = 14                                                           00607*27
      DO 1406 NO=1,NUMCUL                                               00608
       IF (LC.LT.40) GO TO 1409                                         00609
CDEL  CALL PAGE                                                         00610*27
CDEL   WRITE (SYSOUT,4801)                                              00611
```

```
      LC = 7                                                            00612*27
 1409 CONTINUE                                                          00613*32
      BRKBK=' '                                                         00614*32
      IF(IP(NO).EQ.IPRFL2) THEN                                         00615*32
       SL(NO)=100000.                                                   00616*32
       BRKBK=ATSIN                                                      00617*32
       IBRKBK=1                                                         00618*32
      ENDIF                                                             00619*32
      IW=W(NO)                                                          00620
      IH=H(NO)                                                          00621
      IL=L(NO)                                                          00622
      CMXHW=A7BLNK                                                      00623*32
      IF(SMHW(NO).NE.RBLNK) WRITE(CMXHW,'(F7.2)')SMHW(NO)               00624*32
CDEL   WRITE (*,4802) C(NO),S(NO),B(NO),SDI(NO),SWI(NO),SHI(NO),        00625*32
CDEL 1 IL,SMAN(NO),SKEC(NO),SL(NO),BRKBK,IQP(NO),CMXHW,HW(NO),V(NO)     00626*32
 4802 FORMAT (1X,A,4X,A,I5,4X,A,2X,A,2X,A,I8,3X,F6.4,2X,F6.2,4X,F7.5,   00627*32
     1 1X,A,I7,3X,A,F7.2,1X,F7.2)                                       00628*32
       LC=LC+1                                                          00629
      IF(IBRKBK.EQ.1.AND.LC.EQ.38) THEN                                 00630*32
CDEL   WRITE(SYSOUT,1410)                                               00631*32
 1410  FORMAT(/3X,'***** NOTE *****  ''@'' INDICATES A BROKEN BACK',    00632*32
     * ' CONFIGURATION.')                                               00633*32
       LC=LC+2                                                          00634*32
      ENDIF                                                             00635*32
1406  CONTINUE                                                          00636
CDEL  IF(IBRKBK.EQ.1) WRITE(SYSOUT,1410)                                00637*32
      IBRKBK=0                                                          00638*32
CDEL  CALL PAGE                                                         00639*27
      NJOB = A8BLNK                                                     00640*25
      JOB1 = A2BLNK                                                     00641*25
      NUMCUL=0                                                          00642*30
      GO TO 200                                                         00643*30
1405  KC(99)=1                                                          00644
      Q100=0.0                                                          00645
      WTL100=0.0                                                        00646
      RETURN                                                            00647
C                                                                       00648
C     PRECEDING STATEMENT WAS RETURN TO MAIN                            00649
C                                                                       00650
C     DECODE FL-DV CARD                                                 00651
C                                                                       00652
 1500 READ (ACARD,82) A0709,A1619,A3138,A5158                           00653*25
   82 FORMAT (BZ,6X,A,6X,A,11X,A,12X,A)                                 00654*25
      IF (A0709.NE.A3BLNK) GO TO 1502                                   00655*21
CDEL  WRITE (SYSOUT,18)                                                 00656
1501  KC(98)=14                                                         00657
      GO TO 200                                                         00658
1502  IF (A1619.NE.A4BLNK) GO TO 1503                                   00659*21
CDEL  WRITE (SYSOUT,21)                                                 00660
21    FORMAT (  44H CLB0032--BRIDGE CROSS-SECTION I.D. MISSING.  )      00661*20
      GO TO 1501                                                        00662
1503  IF (A3138.NE.A8BLNK) GO TO 1505                                   00663*21
1504  CONTINUE
CDEL  WRITE (SYSOUT,26)                                                 00664
26    FORMAT (  41H CLB0033--FLOW DIVIDE X-DISTANCE MISSING.     )      00665*20
      GO TO 1501                                                        00666
1505  IF (A5158 .EQ.A8BLNK) GO TO 1504                                  00667*21
```

```
      KC(7)=KC(7)+1                                                     00668
      II=KC(6)                                                          00669
      READ (ACARD,83) NAME                                              00670*25
      DO 1506 I=1,II                                                    00671
       IF (BRSUB(I).EQ.NAME) GO TO 1507                                 00672
1506  CONTINUE                                                          00673
      KC(6)=KC(6)+1                                                     00674
      I=KC(6)                                                           00675
      BRSUB(I)=NAME                                                     00676
 1507 READ (ACARD,84) FLSEC,FROMX(I),TOX(I)                             00677*25
   84 FORMAT (BZ,15X,A,11X,F8.0,12X,F8.0)                               00678*25
      ICK(I)=ICK(I)+4                                                   00679*21
      GO TO 200                                                         00680
1600  CONTINUE
CDEL  IF (KC(64).EQ.1.AND.SHAPE.EQ.4.AND.KC(66).EQ.0) WRITE (SYSOUT,29) 00681
29    FORMAT (  41H CLB0034--LAST GIVEN FILL HEIGHT ASSUMED.  )         00682*20
      JOB1=JOBNOB                                                       00683*32
      NJOB=JOBNO                                                        00684*32
      IF (OPENGS.EQ.1) GO TO 1606                                       00685*21
      NDIV=KC(6)                                                        00686*21
      DO 1605 I=1,NDIV                                                  00687*21
      IF (ICK(I).EQ.7) GO TO 1605                                       00688*21
      KC(98)=4                                                          00689*21
 1605 CONTINUE                                                          00690*21
 1606 IF (KC(67).NE.1) GO TO 1601                                       00691*21
      WRITE(2) PRICE                                                    00692
      REWIND 2                                                          00693*27
      READ(2) PRICE                                                     00694
CDEL  CALL PAGE                                                         00695*27
CDEL  WRITE (SYSOUT,6001) PRICE                                         00696
 6001 FORMAT (' CIRC CONC PRICES'/1X,21F6.2//' CIRC CGMP PRICES'/1X,    00697*27
     1 21F6.2//' FLARE PRICES'/1X,21F6.2//' CONC ARCH PRICES'/1X,11F6.2 00698
     2 //' CGM ARCH PRICES'/1X,16F6.2//' CONC PRICE=',F7.2//' STEEL PRIC00699
     3E=',F7.4)                                                         00700
C                                                                       00701
C  REWRITE PERMANENT FILE AND PRINT IT OUT HERE                         00702
C                                                                       00703
1601  RETURN 1                                                          00704
C                                                                       00705
C DECODE COST CARD                                                      00706
C                                                                       00707
1700  KC(64)=1                                                          00708
      READ (ACARD,85) A0709,A1112                                       00709*25
      IF (A1112.NE.STATE) GO TO 200                                     00710*21
      IF (KC(65).EQ.1) GO TO 200                                        00711
      KC(65)=1                                                          00712
C                                                                       00713
C  INITIALIZE COSTCOM TO STATEWIDE                                      00714
C                                                                       00715
      READ(2) PRICE                                                     00716
      GO TO 200                                                         00717
      ENTRY UPDATE                                                      00718
      KC(67)=1                                                          00719
      DO 1702 I=1,92                                                    00720
1702  PRICE(I)=9999999.                                                 00721
      GO TO 200                                                         00722
C                                                                       00723
```

```
C DECODE BOX PRICE CARD
C
 1710 READ (ACARD,50) TEMP1,TEMP2,D6269
50    FORMAT (BZ,21X,F5.2,15X,F5.3,15X,F8.0)
      IF (KC(65).EQ.1) KC(65)=2
      IF (D6269.EQ.0.0) GO TO 1711
      COSFT=D6269
      KC(62)=1
      GO TO 200
1711  IF (TEMP1.EQ.0.0.OR.TEMP2.EQ.0.0) GO TO 1712
      STL=TEMP2
      CONC=TEMP1
      GO TO 200
1712  IF (KC(65).NE.0) GO TO 1713
CDEL  WRITE (SYSOUT,27)
27    FORMAT (  41H CLB0035--DATA MISSING ON BOX PRICE CARD.  )
      GO TO 1714
1713  CONTINUE
CDEL  WRITE (SYSOUT,28)
28    FORMAT (' STATEWIDE AVERAGE USED FOR MISSING VALUE')
1714  IF (TEMP1.NE.0.0) CONC=TEMP1
      IF (TEMP2.NE.0.0) STL=TEMP2
      GO TO 200
C
C DECODE PIPE PRICE CARD
C
 1800 READ (ACARD,51) TEMP1,TEMP2,RISE,AWID,F6367
51    FORMAT (BZ,16X,F5.2,10X,F5.2,4X,2F5.0,12X,F5.0)
      RISE=RISE/12.
      AWID=AWID/12.
      IF (KC(65).EQ.1) KC(65)=2
      IF (RISE.NE.0.0.AND.RISE.LE.10.0) GO TO 1801
CDEL  WRITE (SYSOUT,30)
30    FORMAT (  34H CLB0036--PIPE SIZE NOT AVAILABLE.  )
CDEL  IF (KC(65).NE.0) WRITE (SYSOUT,28)
      GO TO 200
1801  ITYP=1
      IF (AWID.NE.0.0.AND.RISE.NE.AWID) ITYP=4
      IF (TEMP1.EQ.0.0) GO TO 1802
      CALL IINDEX(J,RISE,ITYP+1)
      PRC(J)=TEMP1
1802  IF (TEMP2.EQ.0.0) GO TO 1803
      CALL IINDEX(J,RISE,ITYP)
      PRC(J)=TEMP2
1803  IF (F6367.EQ.0.0) GO TO 200
      IDUM = 3
      CALL IINDEX (J,RISE,IDUM)
      PRC(J) = F6367
      GO TO 200
C
C  DECODE FILL HEIGHT CARD
C
 1810 READ (ACARD,53) TEMP3,FILLH
   53 FORMAT (BZ,2X,A,6X,F3.0)
      IF (TEMP3.EQ.FINISH) GO TO 1405
      KC(66)=1
      GO TO 200
```

```
C                                                                       00780
C  DECODE MISC COSTS                                                    00781
C                                                                       00782
1820  READ (99,54) TEMP1                                                00783
54    FORMAT (11X,F8.0)                                                 00784
      CMISC=CMISC+TEMP1                                                 00785
      GO TO 200                                                         00786
 9999 CONTINUE
      RETURN
      END                                                               00849
      SUBROUTINE CULBRC(HWC,VEC)                                        00001
C                                                                       00002*49
C  CULBRC SELECTS THE PROPER ROUTINES TO BE CALLED TO PERFORM CULVERT   00003*49
C  DESIGN OR ANALYSIS DEPENDING ON THE DESCRIPTIONS READ IN CULBRR.     00004*49
C  IT ALSO OUTPUTS SOME CULVERT INFORMATION AND STORES OTHER ITEMS      00005*49
C  FOR LATER USE IN SUMMARY REPORTS                                     00006*49
C                                                                       00007*49
      DOUBLE PRECISION X100                                             00008*41
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH,      00009*47
     1 INSTA1,INEL1,L                                                   00010*47
      INTEGER SHAPE,PROFIL,OPENGS,B                                     00011*41
      DIMENSION EXES(2)                                                 00012
      COMMON ACRES,CA,FREQ,QPEAK,TC,       ISECN(50,50),ISTA(50),       00013
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00014*41
      COMMON/COSCOM/PRC(90),CONC,STL,FILLH,CMISC,COSFT,TOTCOS           00015
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00016
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00017
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00018*33
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00019*46
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00020*33
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00021*33
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00022*41
      COMMON/FCOM/HW(100),SL(100),V(100),B(100),H(100),IQP(100),        00024*41
     1 L(100),NUMCUL,W(100)                                             00025*41
      COMMON/F100/N100,CLREL,HEL,Q100,V100,WTL100,X100(100),Y100(100)   00026
      COMMON/CCOM1/BRSUB(10),CLVTID,FLSEC,NAME,ORIGID,ROADID            00027*41
      COMMON/FCOM1/JOBNO,JOBNOB,IN(100),IP(100),M(100),C(100),          00028*48
     *  S(100),SHI(100),SWI(100),SDI(100)                               00029*48
      COMMON/ID/MOVEID,TOID,GSEC(50),CONYID,NAM,IS1,IS2,IDSEC(50)       00030*41
      CHARACTER*80 ACARD
      CHARACTER*80 ACARD1,ACARD2,ACARD3,ACARD4,ACARD5,ACARD6,ACARD7     00031*41
      COMMON/CARD/ACARD,ACARD1,ACARD2,ACARD3,ACARD4,ACARD5,ACARD6,ACARD700032*41
      CHARACTER*2 JOBNOB                                                00033*41
      CHARACTER*3 CLVTID,C,BRSUB,NAME,ROADID                            00034*41
      CHARACTER*4 SHAPE1,SHAPE2,SHAPE3,SHAPE4,A4BLNK,EXES,ISHAP,S,FLSEC,00035*41
     1 ORIGID,MOVEID,TOID,GSEC,CONYID,NAM,IS1,IS2,IDSEC                 00036*41
      CHARACTER*6 INLET1,INLET2,INLET3,NNLET,IN                         00037*41
      CHARACTER*4 SHI,SWI,SDI                                           00038*48
      CHARACTER*8 IPRFL1,IPRFL2,IPRFL3,MAT1,MAT2,MAT3,MAT4,IPRFIL,MTR,  00039*41
     1 JOBNO,IP,M                                                       00040*41
      DATA IPRFL1,IPRFL2,IPRFL3,SHAPE1,SHAPE2,SHAPE3,SHAPE4,INLET1,     00041
     1 INLET2,INLET3,MAT1,MAT2,MAT3,A4BLNK/'STRAIGHT','BROKN BK',       00042
     2 'STEPPED ','CIRC','ARCH','OVAL','BOX ','FLARED',' DROP ',        00043
     3 'NORMAL','CONCRETE','  CGM   ','ST PLATE','    '/,EXES/'    ',   00044
     1 'XXXX'/,MAT4/'        '/                                         00045*30
      READ (A4BLNK,FMT='(A4)') RBLNK                                    00046*46
C                                                                       00047
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C     TEST ERROR FLAG AND STORAGE CAPACITY                                      00048
C                                                                               00049
      IF(KC(31).NE.1.OR.SHAPE.NE.4) GO TO 3                                     00050*46
      HIGH=HIGH*12.                                                             00051*46
      WIDE=WIDE*12.                                                             00052*46
   3  I=0                                                                       00053*46
      HIFT=HIGH/12.0                                                            00054*46
      WIFT=WIDE/12.0                                                            00055*46
      IF(Q100.GT.0.001.AND.WTL100.GT.0.001) KC(27)=1                            00056
C                            FOR BRIDGE DESIGN, MULTIPLE OPENINGS,              00057*35
C                            KC ( 27 ) NEEDS TO BE 0 (ZERO).                    00058*35
      IF ( KC (1) .EQ. 1 .AND. KC (3) .EQ. 1 .AND.                              00059*35
     *                    OPENGS .GT. 1  )     KC ( 27 ) = 0                    00060*35
      IF (KB(97).NE.1) GO TO 1604                                               00061
CDEL  WRITE (SYSOUT,591) QPEAK                                                  00062
591   FORMAT (  66H CLB0037--TAILWATER FROM SUBSYSTEM HYDRA IS NOT REALI00063*31
     $STIC FOR Q =  , F8.1, 1H.  )                                              00064*31
      KC(98)=27                                                                 00065
1604  IF (KC(5).LT.05) GO TO 1613                                               00066
CDEL  WRITE (SYSOUT,54)                                                         00067
54    FORMAT (  62H CLB0038--NUMBER OF BREAK STATIONS READ EXCEEDS CAPAC00068*31
     $ITY OF 4. )                                                               00069*31
      I=1                                                                       00070
1613  IF (KC(6).LT.11) GO TO 1614                                               00071
CDEL  WRITE (SYSOUT,49)                                                         00072
49    FORMAT (  68H CLB0039--NUMBER OF BRIDGE SUB-SECTIONS READ EXCEEDS 00073*31
     $CAPACITY OF 10.  )                                                        00074*31
      I=1                                                                       00075
1614  IF (KC(7).LT.11) GO TO 1602                                               00076
CDEL  WRITE (SYSOUT,23)                                                         00077
23    FORMAT (  66H CLB0041--NUMBER OF FLOW DIVIDE CARDS READ EXCEEDS CA00078*31
     $PACITY OF 10.  )                                                          00079*31
      I=1                                                                       00080
1602  IF (KC(98).NE.0) GO TO 1601                                               00081
      IF (I.EQ.0) GO TO 1700                                                    00082
      GO TO 1603                                                                00083
 1601 KC98=KC(98)                                                               00084*32
      GO TO (61,62,63,64,65,66,67,68,69,70,71,72,73,74),KC98                    00085*32
      GO TO 1603                                                                00086*32
   61 CONTINUE
CDEL  WRITE (SYSOUT,27)                                                         00087*32
      GO TO 1603                                                                00088*32
   62 CONTINUE
CDEL  WRITE (SYSOUT,28)                                                         00089*32
      GO TO 1603                                                                00090*32
   63 CONTINUE
CDEL  WRITE (SYSOUT,29)                                                         00091*32
      GO TO 1603                                                                00092*32
   64 CONTINUE
CDEL  WRITE (SYSOUT,38)                                                         00093*32
      GO TO 1603                                                                00094*32
   65 CONTINUE
CDEL  WRITE (SYSOUT,30)                                                         00095*32
      GO TO 1603                                                                00096*32
   66 CONTINUE
CDEL  WRITE (SYSOUT,31)                                                         00097*32
      GO TO 1603                                                                00098*32
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   67 CONTINUE
CDEL  WRITE (SYSOUT,29)                                                  00099*32
      GO TO 1603                                                         00100*32
   68 CONTINUE
CDEL  WRITE (SYSOUT,32)                                                  00101*32
      GO TO 1603                                                         00102*32
   69 CONTINUE
CDEL  WRITE (SYSOUT,33)                                                  00103*32
      GO TO 1603                                                         00104*32
   70 CONTINUE
CDEL  WRITE (SYSOUT,34)                                                  00105*32
      GO TO 1603                                                         00106*32
   71 CONTINUE
CDEL  WRITE (SYSOUT,35)                                                  00107*32
      GO TO 1603                                                         00108*32
   72 CONTINUE
CDEL  WRITE (SYSOUT,36)                                                  00109*32
      GO TO 1603                                                         00110*32
   73 CONTINUE
CDEL  WRITE (SYSOUT,36)                                                  00111*32
      GO TO 1603                                                         00112*32
   74 CONTINUE
CDEL  WRITE (SYSOUT,37)                                                  00113*32
1603  CONTINUE
CDEL  WRITE (SYSOUT,93)                                                  00114
93    FORMAT (  38H CLB0040--ERRORS PRECLUDE COMPUTATION.   )            00115*31
CDEL  CALL PAGE                                                          00116*43
      GO TO 201                                                          00117*46
27    FORMAT (  46H CLB0042--DATA MISSING ON CULBRG CONTROL CARD.  )     00118*31
28    FORMAT (  42H CLB0043--DATA MISSING ON SUPPLY CARD C-1.      )     00119*31
29    FORMAT (  41H CLB0044--DATA MISSING ON CLVRT CARD C-2.       )     00120*31
30    FORMAT (  41H CLB0045--DATA MISSING ON CLVRT CARD C-3.       )     00121*31
31    FORMAT (  41H CLB0046--DATA MISSING ON CLVRT CARD C-4.       )     00122*31
32    FORMAT (  41H CLB0047--DATA MISSING ON CLVRT CARD C-5.       )     00123*31
33    FORMAT (  41H CLB0048--DATA MISSING ON CLVRT CARD C-6.       )     00124*31
34    FORMAT (  41H CLB0049--DATA MISSING ON CLVRT CARD C-7.       )     00125*31
35    FORMAT (  40H CLB0050--DATA MISSING ON ROAD CARD C-8.        )     00126*31
36    FORMAT (  48H CLB0051--DATA MISSING ON BRDG CARD C-9 OR C-10.)     00127*31
37    FORMAT (  42H CLB0052--DATA MISSING ON FL-DV CARD C-11.      )     00128*31
   38 FORMAT ( 76H CLB0113--FOR EACH FLOW DIVIDE A C-9 BRDG CARD, A C-1000129*32
     1 BRDG CARD, AND A C-11,/, 65H          FL-DV CARD WITH IDENTICAL S00130*32
     2UBSECTIONS MUST BE PROVIDED.)                                      00131*32
C                                                                        00132
C     TEST DATA - SELECT DESIGN/ANALYSIS, BRIDGE/CULVERT                 00133
C                                                                        00134
1700  IF (QPEAK.NE.0.0) GO TO 1701                                       00135
      IF(Q100.GT.0.001.AND.KC(2).EQ.1) GO TO 1701                        00136
CDEL  WRITE (SYSOUT,4)                                                   00137
4     FORMAT ( 36H CLB0053--NO Q SUPPLIED OR COMPUTED.    )              00138*31
      IF(KC(27).EQ.1) GO TO 200                                          00139
      GO TO 1603                                                         00140
1701  IF (WATEL.NE.0.0) GO TO 1702                                       00141
      IF(WTL100.GT.0.001.AND.KC(2).EQ.1) GO TO 200                       00142
      IF (KC(3).NE.1) GO TO 1710                                         00143
CDEL  WRITE (SYSOUT,1051)                                                00144
1051  FORMAT (  72H CLB0054--TAILWATER ELEVATION NOT SUPPLIED.  BRIDGE C00145*31
     $ANNOT BE PROCESSED. )                                              00146*31
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      GO TO 1603                                                        00147
1710  CONTINUE
CDEL  WRITE (SYSOUT,1050)                                               00148
1050  FORMAT (  76H CLB0055--NO TAILWATER ELEVATION GIVEN.  IT IS ASSUME00149*31
     $D TO BE THE SAME AS THE  / 10X,17HOUTLET ELEVATION.   )           00150*31
      WATEL=OUTEL                                                       00151
      KC(25)=1                                                          00152*34
1702  IF (KC(1).EQ.1) GO TO 1703                                        00153
      IF (KC(2).EQ.1) GO TO 2000                                        00154
CDEL  WRITE (SYSOUT,1)                                                  00155
1     FORMAT (  48H CLB0056--NEITHER DESIGN NOR ANALYSIS SPECIFIED.   ) 00156*31
      GO TO 1603                                                        00157
1703  IF (KC(3).EQ.1) GO TO 1800                                        00158
      IF (KC(4).NE.1) GO TO 200                                         00159
      IF (MAT.EQ.1) GO TO 1900                                          00160
      IF (KECF.NE.0.2) GO TO 1900                                       00161
      KECF=0.5                                                          00162
CDEL  WRITE (SYSOUT,550)                                                00163
550   FORMAT (  81H CLB0057--WHEN PIPE OTHER THAN CONCRETE IS SPECIFIED,00164*31
     $ KE VALUE MAY NOT EQUAL 0.2.    / 10X,   17HVALUE SET AT 0.5.  )  00165*31
      GO TO 1900                                                        00166
C                                                                       00167
C     DESIGN SINGLE AND MULTIPLE OPENING BRIDGES                        00168
C                                                                       00169
 1800 CALL RC3(*1603)                                                   00170*41
      GO TO 200                                                         00171
C                                                                       00172
C     TEST CULVERT DESIGN DATA                                          00173
C                                                                       00174
1900  IF (OPENGS.EQ.1) GO TO 1901                                       00175
CDEL  WRITE (SYSOUT,52)                                                 00176
52    FORMAT (  79H CLB0058--ROUTINE NOT AVAILABLE TO DESIGN OR ANALYZE 00177*31
     $MULTIPLE OPENING CULVERTS. )                                      00178*31
      GO TO 1603                                                        00179
 1901 IF(MAXHW.NE.RBLNK) GO TO 1902                                     00180*46
CDEL  WRITE (SYSOUT,13)                                                 00181
13    FORMAT (  39H CLB0059--MAXIMUM H.W. ELEV. NOT GIVEN.  )           00182*31
      GO TO 1603                                                        00183
 1902 IF(OUTSTA.NE.RBLNK) GO TO 1904                                    00184*46
1903  CONTINUE
CDEL  WRITE (SYSOUT,10)                                                 00185
10    FORMAT (  55H CLB0060--CULVERT STATIONING AND ELEVATIONS INCOMPLET00186*31
     $E.  )                                                             00187*31
      GO TO 1603                                                        00188
1904  IF (MAXHW.GT.WATEL+0.05) GO TO 1905                               00189
CDEL  WRITE (SYSOUT,1052)                                               00190
1052  FORMAT (  75H CLB0061--TAILWATER ELEVATION IS GREATER THAN OR EQUA00191*31
     $L TO MAXIMUM HEADWATER    /                                       00192*31
     2              10X,  66HELEVATION - 0.05 FOOT.  THIS CONDITION IS I00193*31
     3MPOSSIBLE TO SATISFY IN    /                                      00194*31
     4              10X,  22HDESIGNING A STRUCTURE.    )                00195*31
      GO TO 1603                                                        00196
 1905 IF(OUTEL.EQ.RBLNK) GO TO 1903                                     00197*46
      IF(INSTA.EQ.RBLNK) GO TO 1903                                     00198*46
CDEL  IF (MAXHW.LT.WATEL+0.1) WRITE (SYSOUT,1906)                       00199
1906  FORMAT (  78H CLB0062--THE DIFFERENCE BETWEEN THE MAXIMUM HEADWATE00200*31
     $R ELEVATION AND TAILWATER    /                                    00201*31
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     2              10X,  71HELEVATION IS LESS THAN 0.1 FOOT.  DESIGN WA00202*31
     3S ATTEMPTED BUT CULVERT SIZE /                                    00203*31
     4              10X,  21HMAY NOT BE REALISTIC.   )                  00204*31
      IF(INEL.EQ.RBLNK) GO TO 1903                                      00205*46
      IF (DEPTH.NE.0.0) GO TO 2100                                      00206
CDEL  WRITE (SYSOUT,17)                                                 00207
17    FORMAT (  55H CLB0063--NO MAX BARREL DEPTH GIVEN FOR CULVERT DESIG00208*31
     $N.  )                                                             00209*31
      GO TO 1603                                                        00210
C                                                                       00211
C     ANALYZE SINGLE AND MULTIPLE OPENING BRIDGES.                      00212
C                                                                       00213
2000  IF (KC(3).NE.1) GO TO 3000                                        00214
      IF (OPENGS.NE.1) GO TO 2001                                       00215
      CALL RC3(*1603)                                                   00216*41
      GO TO 200                                                         00217
2001  LL=KC(7)                                                          00218
      DO 2002 NL=1,LL                                                   00219
       I=NL                                                             00220
      CALL RC9(I,J,*1603)                                               00221*41
2002  CONTINUE                                                          00222
      CALL RC10                                                         00223
      GO TO 200                                                         00224
C                                                                       00225
C     CULVERT DESIGN                                                    00226
C                                                                       00227
2100  IFREQ=FREQ+.5                                                     00228
CDEL  CALL PAGE                                                         00229*43
CDEL  WRITE (SYSOUT,4310) JOBNOB,JOBNO,CLVTID,QPEAK,IFREQ,WATEL         00230
 4310 FORMAT(//10X,'DESIGN SINGLE OPENING CULVERT',7X,'JOB NUMBER=',    00231*43
     2 A2,A8//10X,'CULVERT ID = ',A3//10X,'DESIGN FLOW =',F7.1,' CFS    00232*43
     3   FREQUENCY =',I4,' YEAR'//10X,'TAILWATER ELEVATION =',F8.2,     00233*43
     4 ///2X,                                                           00234*43
     4 'BBLS   DIAM   WIDE   HIGH  LENGTH   ALLOW.   CALC.   CALC.   ALL00235
     5OW.   CALC.   TOTAL'/37X,'HW ELEV  HW ELEV   HW     VELOC.  VELOC.00236
     6  COST($)'/)                                                      00237
      GO TO (2101,2500,2800), PROFIL                                    00238
CDEL  WRITE (SYSOUT,47)                                                 00239
47    FORMAT (  40H CLB0064--CULVERT PROFILE NOT SPECIFIED. )           00240*31
      GO TO 1603                                                        00241
2101  GO TO (2102,2300,2305,2400), SHAPE                                00242
CDEL  WRITE (SYSOUT,46)                                                 00243
46    FORMAT (  38H CLB0065--CULVERT SHAPE NOT SPECIFIED. )             00244*31
      GO TO 1603                                                        00245
2102  GO TO (2103,2104,2105), INLET                                     00246
2106  CONTINUE
CDEL  WRITE (SYSOUT,9)                                                  00247
9     FORMAT (  49H CLB0066--TYPE OF INLET CONDITIONS NOT SPECIFIED. )  00248*31
      GO TO 1603                                                        00249
 2103 CALL RC12 (INSTA1,OUTST1,INEL1,OUTEL1,*1603)                      00250*47
      IF (KC(36).NE.1) GO TO 2201                                       00251
      IF (KC(38).NE.1) GO TO 203                                        00252
      INLET=IOLD                                                        00253
      KC(38)=0                                                          00254
      GO TO 203                                                         00255
2104  CALL RC13                                                         00256
      GO TO 203                                                         00257
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 2105 CALL RC11(INSTA1,OUTST1,INEL1,OUTEL1,*203)                        00258*41
C                                                                       00259
C     TEST FOR CRITICAL SLOPE AND EXIT VELOCITY - MODIFY CULVERT DESIGN 00260
C                                                                       00261
CDEL  CALL RPRT43 (INSTA1,OUTST1,INEL1,OUTEL1)                          00262
      IF (SLOPE.LT.CRSLPE) GO TO 2202                                   00263
CDEL  WRITE (SYSOUT,44)                                                 00264
      IF (MAT.EQ.3) GO TO 2202                                          00265
      IF (KC(60).EQ.1) GO TO 2202                                       00266
CDEL  WRITE (SYSOUT,55)                                                 00267
55    FORMAT(///68H CLB0067--ANOTHER CULVERT DESIGN WILL BE TRIED USING 00268*31
     $A FLARED INLET.  )                                                00269*31
CDEL  IF (VO.GT.VMAX) WRITE (SYSOUT,45)                                 00270
44    FORMAT (///' SUPER CRITICAL SLOPE')                               00271
      IOLD=INLET                                                        00272
      INLET=1                                                           00273
      GO TO 2100                                                        00274
2201  CONTINUE
CDEL  CALL RPRT43 (INSTA1,OUTST1,INEL1,OUTEL1)                          00275
      IF (KC(38).EQ.1) INLET =IOLD                                      00276
      KC(38)=0                                                          00277
2202  IF (VO.LE.VMAX) GO TO 203                                         00278
CDEL  WRITE (SYSOUT,45)                                                 00279
45    FORMAT(///62H CLB0068--CALCULATED EXIT VELOCITY EXCEEDS ALLOWABLE 00280*31
     $VELOCITY.  )                                                      00281*31
      GO TO 203                                                         00282
C                                                                       00283
C     CULVERT DESIGN                                                    00284
C                                                                       00285
2300  GO TO (2301,2302,2303), INLET                                     00286
      GO TO 2106                                                        00287
2301  CONTINUE
CDEL  WRITE(SYSOUT,660)                                                 00288
660   FORMAT (  67H CLB0069--FLARED INLET MAY NOT BE SPECIFIED FOR THIS 00289*31
     $CULVERT SHAPE. )                                                  00290*31
      GO TO 1603                                                        00291
2302  CALL RC15                                                         00292
      GO TO 203                                                         00293
2303  CALL RC14 (INSTA1,OUTST1,INEL1,OUTEL1)                            00294
      GO TO 2201                                                        00295
2305  GO TO (2301,2307,2308), INLET                                     00296
      GO TO 2106                                                        00297
2307  CALL RC17                                                         00298
      GO TO 203                                                         00299
2308  CALL RC16                                                         00300
      GO TO 203                                                         00301
C                                                                       00302
C     CULVERT DESIGN - TEST CRITICAL SLOPE, NO. OF BARRELS AND MODIFY   00303
C     DESIGN                                                            00304
C                                                                       00305
2400  GO TO (2401,2402,2403), INLET                                     00306
      GO TO 2106                                                        00307
2401  CALL RC19                                                         00308
      GO TO 203                                                         00309
2402  CALL RC20                                                         00310
      GO TO 203                                                         00311
 2403 CALL RC18 (INSTA1,OUTST1,INEL1,OUTEL1,BWHEL,*1603)                00312*47
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CDEL  CALL RPRT43 (INSTA1,OUTST1,INEL1,OUTEL1)
CDEL  IF (KC(68).NE.0) WRITE (SYSOUT,5305) EXES(2)
      IF (SLOPE.LT.CRSLPE) GO TO 2202
CDEL  WRITE (SYSOUT,44)
      GO TO 2202
C
C     CULVERT DESIGN AND DESIGN MODIFICATION
C
2500  GO TO (2501,2600,2604,2700), SHAPE
CDEL  WRITE (SYSOUT,46)
      GO TO 1603
2501  GO TO (2502,2503,2504), INLET
      GO TO 2106
2502  CALL RC22
      GO TO 203
2503  CALL RC23
      GO TO 203
2504  CALL RC21
      GO TO 203
C
C     CULVERT DESIGN
C
2600  GO TO (2301,2602,2603), INLET
      GO TO 2106
2602  CALL RC25
      GO TO 203
2603  CALL RC24
      GO TO 203
2604  GO TO (2301,2606,2607), INLET
      GO TO 2106
2606  CALL RC27
      GO TO 203
2607  CALL RC26
      GO TO 203
C
C     CULVERT DESIGN
C
2700  GO TO (2701,2702,2703), INLET
      GO TO 2106
2701  CALL RC29
      GO TO 203
2702  CALL RC30
      GO TO 203
2703  CALL RC28
      GO TO 203
C
C     CULVERT DESIGN
C
2800  GO TO (2801,2805,2900,2904), SHAPE
CDEL  WRITE (SYSOUT,46)
      GO TO 1603
2801  GO TO (2802,2803,2804), INLET
      GO TO 2106
2802  CALL RC32
      GO TO 203
2803  CALL RC33
      GO TO 203
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2804  CALL RC31                                                    00370
      GO TO 203                                                    00371
2805  GO TO (2301,2807,2808), INLET                                00372
      GO TO 2106                                                   00373
2807  CALL RC35                                                    00374
      GO TO 203                                                    00375
2808  CALL RC34                                                    00376
      GO TO 203                                                    00377
C                                                                  00378
C     CULVERT DESIGN - STEPPED OVAL OR BOX                         00379
C                                                                  00380
2900  GO TO (2301,2902,2903), INLET                                00381
      GO TO 2106                                                   00382
2902  CALL RC37                                                    00383
      GO TO 203                                                    00384
2903  CALL RC36                                                    00385
      GO TO 203                                                    00386
2904  GO TO (2301,2906,2907), INLET                                00387
      GO TO 2106                                                   00388
2906  CALL RC39                                                    00389
      GO TO 203                                                    00390
2907  CALL RC38                                                    00391
      GO TO 203                                                    00392
C                                                                  00393
C     ANALYZE CULVERTS - TEST DATA                                 00394
C                                                                  00395
3000  IF (KC(4).EQ.1) GO TO 3005                                   00396
CDEL  WRITE (SYSOUT,2)                                             00397
2     FORMAT (  47H CLB0070--NEITHER BRIDGE NOR CULVERT SPECIFIED.  )  00398*31
      GO TO 1603                                                   00399
3005  IF (MAT.EQ.1) GO TO 3001                                     00400
      IF(KECF.NE.0.2)GO TO 3001                                    00401
      KECF=0.5                                                     00402
CDEL  WRITE(SYSOUT,550)                                            00403
3001  IF (OPENGS.EQ.1) GO TO 3002                                  00404
CDEL  WRITE (SYSOUT,52)                                            00405
      GO TO 1603                                                   00406
 3002 IF(OUTSTA.NE.RBLNK) GO TO 3004                               00407*46
3003  CONTINUE
CDEL  WRITE (SYSOUT,10)                                            00408
      GO TO 1603                                                   00409
 3004 IF(OUTEL.EQ.RBLNK) GO TO 3003                                00410*46
      IF(INSTA.EQ.RBLNK) GO TO 3003                                00411*46
      IF(INEL.EQ.RBLNK) GO TO 3003                                 00412*46
C                                                                  00413
C     CULVERT ANAYLSIS                                             00414
      IF(KC(31).EQ.1) GO TO 3109                                   00415
CDEL  WRITE (SYSOUT,92)                                            00416
92    FORMAT (  47H CLB0071--CULVERT DIMENSIONS CARD NOT SUPPLIED.  )  00417*31
      GO TO 1603                                                   00418
3109  GO TO (3101,3106,3600),PROFIL                                00419
CDEL  WRITE (SYSOUT,47)                                            00420
      GO TO 1603                                                   00421
3101  GO TO (3102,3200,3204,3300), SHAPE                           00422
CDEL  WRITE (SYSOUT,46)                                            00423
      GO TO 1603                                                   00424
3102  GO TO (3103,3104,3105), INLET                                00425
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      GO TO 2106                                                        00426
 3103 CALL RC41 (BWHEL,*1603)                                           00427*47
      GO TO 3106                                                        00428
3104  CALL RC42                                                         00429
      GO TO 203                                                         00430
3105  CONTINUE
      IF(IGATE.EQ.0)CALL RC40   (BWHEL,QPPE,CRITDE,TWE,*1603)
      IF(IGATE.EQ.1)CALL RC40FLP(BWHEL,QPPE,CRITDE,TWE,*1603)
      IF(IGATE.EQ.2)CALL RC40FLX(BWHEL,QPPE,CRITDE,TWE,*1603)
C3105 CALL RC40(BWHEL,QPPE,CRITDE,TWE,*1603)
C3105 CALL RC40 (BWHEL,*1603)
3106  IF (PROFIL.EQ.1) IPRFIL=IPRFL1                                    00432
      IF (PROFIL.EQ.2) IPRFIL=IPRFL2                                    00433
      IF (PROFIL.EQ.3) IPRFIL=IPRFL3                                    00434
      IF (SHAPE.NE.1) GO TO 3113                                        00435
      WIDE=0.                                                           00436
      HIGH=0.                                                           00437
      ISHAP=SHAPE1                                                      00438
      GO TO 3114                                                        00439
3113  IF (SHAPE.EQ.2) ISHAP= SHAPE2                                     00440
      IF (SHAPE.EQ.3) ISHAP= SHAPE3                                     00441
      IF (SHAPE.EQ.4) ISHAP=SHAPE4                                      00442
      DIAM=0.                                                           00443
      DIFT=0.                                                           00444*46
3114  IF (INLET.EQ.1) NNLET=INLET1                                      00445
      IF (INLET.EQ.2) NNLET=INLET2                                      00446
      IF (INLET.EQ.3) NNLET=INLET3                                      00447
      IF (MAT.EQ.1) MTR=MAT1                                            00448
      IF (MAT.EQ.2) MTR=MAT2                                            00449
      IF (MAT.EQ.3) MTR=MAT3                                            00450
      IF(MAT.EQ.0) MTR=MAT4                                             00451*30
      NNSTA=INSTA                                                       00452
      IOTSTA=OUTSTA                                                     00453
      IDIAM=DIAM                                                        00454
      WI=WIDE                                                           00455*46
      HI=HIGH                                                           00456*46
      ILEN=LENGTH                                                       00457
      IBBLS=BBLS                                                        00458
      IFREQ=FREQ                                                        00459
      IF(SHAPE.NE.4) GO TO 3115                                         00460*46
      WI=WIFT                                                           00461*46
      HI=HIFT                                                           00462*46
 3115 IF(PROFIL.EQ.2) GO TO 3108                                        00463*46
CDEL  CALL PAGE                                                         00464*43
CDEL  WRITE (SYSOUT,53) JOBNOB,JOBNO,CLVTID                             00465
   53 FORMAT (//10X,'ANALYZE SINGLE OPENING CULVERT    JOB NUMBER = ',  00466*43
     1 A,A//10X,'CULVERT ID =  ',A/)                                    00467*43
      HWC=BWHEL
      VEC=VO
CDEL  WRITE (SYSOUT,5303) QPEAK,IFREQ,WATEL,IBBLS,IDIAM,WI,HI,          00468*46
CDEL 1 ILEN,BWHEL,BWH,VO,TOTCOS,EXES(KC(68)+1)                          00469
5303  FORMAT (10X,'FLOW =',F7.1,' CFS',21X,'FREQUENCY = ',I3,' YEAR'//  00470
     110X,'TAILWATER = ',F7.2//40X,'H.W.     CALC.',12X,'TOTAL'/2X,'BBLS00471
     2   DIAM   WIDE   HIGH   LENGTH    ELEV.    H.W.    VELOC.  COST($)00472
     3'//2X,I3,I7,1X,2F7.1,I8,F11.2,F8.2,F8.2,2X,F7.0,A1//)             00473
CDEL  WRITE (SYSOUT,5304) NNSTA,INEL,IOTSTA,OUTEL                       00474*38
5304   FORMAT (10X,'INLET  STATION = ',I7,15X,'ELEVATION = ',F7.2//10X, 00475
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     1 'OUTLET STATION =',I8,15X,'ELEVATION = ',F7.2)                   00476
      IF(INLET.EQ.1)GO TO 3107                                          00477
CDEL  WRITE (SYSOUT,5302) SLOPE,IPRFIL,ISHAP,NNLET,KECF,MTR,MANN        00478
5302  FORMAT (/38X,'INLET'/12X,'SLOPE    PROFILE  SHAPE   TYPE    KE    00479
     1MATERIAL   ''N'''//11X,F7.5,2X,A,3X,A,2X,A,2X,F4.2,3X,A,F7.3)     00480*41
      GO TO 3112                                                        00481
 3107 CONTINUE
CDEL  WRITE(SYSOUT,5301)SLOPE,IPRFIL,ISHAP,NNLET,MTR,MANN               00482
5301  FORMAT (/38X,'INLET'/12X,'SLOPE    PROFILE  SHAPE   TYPE    KE    00483
     1MATERIAL   ''N'''//11X,F7.5,2X,A,3X,A,2X,A,2X,'----',3X,A,F7.3    00484*41
     .)                                                                 00485
      GO TO 3112                                                        00486
C                                                                       00487
C BROKEN-BACK CULVERT OUTPUT                                            00488
C                                                                       00489
 3108 IDIAM=DIAM                                                        00490*46
      IF (MANN.EQ.1.) MANN=0.012                                        00491
      IF (MANN.EQ.2.) MANN=0.024                                        00492
      IF(MANN.EQ.3.) MANN=10.**((ALOG10(DIFT+10.)-4.15076)/(-5.77698)   00493*46
     1 -2.)                                                             00494
CDEL  CALL PAGE                                                         00495*43
CDEL  WRITE(SYSOUT,56)CLVTID,JOBNOB,JOBNO,NNSTA,INEL,IOTSTA,OUTEL,      00496
CDEL 1 IPRFIL,ISHAP,NNLET,KECF,MTR,MANN                                 00497
   56 FORMAT (//10X,'ANALYZE SINGLE OPENING BROKEN BACK CULVERT'//      00498*43
     1 10X,'CULVERT ID = ',A,22X,'JOB NUMBER = ',A,A//10X,'INLET  STATIO00499*41
     2N =',I8,17X,'ELEVATION = ',F8.2//10X,'OUTLET STATION =',I8,17X,   00500*41
     3 'ELEVATION = ',F8.2//34X,'INLET'/11X,'PROFILE    SHAPE       TYPE00501
     4       KE      MATERIAL     ''N'''//10X,A,6X,A,5X,A,F8.2,5X,A,    00502*41
     5 F10.3///24X,'BROKEN BACK CULVERT CONFIGURATION'//41X,'UPSTREAM', 00503
     6 11X,'DOWNSTREAM'/10X,'UNIT   SLOPE     LENGTH      STA.   ELEV.',00504
     7 8X,'STA.   ELEV.'/)                                              00505
      GO TO 3400                                                        00506
3110  CONTINUE
      HWC=BWHEL
      VEC=VO
CDEL  WRITE (SYSOUT,57) CRSLPE,QPEAK,IFREQ,WATEL,IBBLS,IDIAM,WI,HI,     00507*46
CDEL 1 BWHEL,BWH,VO,TOTCOS,EXES(KC(68)+1)                               00508
57    FORMAT(/10X,'CRITICAL SLOPE =',F8.5,//10X,'FLOW =',F7.1,' CFS',24X00509
     1,'FREQUENCY =',I4,' YEAR'//10X,'TAILWATER =',F8.2//48X,'H.W.     C00510
     2ALC.',12X,'TOTAL'/10X,'BBLS      DIAM      WIDE       HIGH     ELEV. 00511
     3    H.W.    VELOC.  COST($)'//10X,I3,I10,F9.1,F10.1,F11.2,F9.2,   00512
     4 F9.2,2X,F7.0,2X,A1)                                              00513
      IF(KC(54).EQ.1)GO TO 3111                                         00514
CDEL  WRITE(SYSOUT,58)                                                  00515
58    FORMAT(//10X,'HYDRAULIC JUMP DOES NOT OCCUR')                     00516
      GO TO 3112                                                        00517
3111  CONTINUE
CDEL  WRITE(SYSOUT,59)                                                  00518
59    FORMAT (///10X,'HYDRAULIC JUMP OCCURS - VELOCITY BASED ON EXIT DEP00519
     1TH AFTER'/15X,'HYDRAULIC JUMP')                                   00520
3112  CONTINUE
CDEL  CALL PAGE                                                         00521*43
      IF(PROFIL.EQ.2.AND.INLET.EQ.3.AND.KC(27).EQ.1) GO TO 4000         00522*40
CDEL  CALL RPT43S (MTR,ISHAP,NNLET,IPRFIL)                              00523*38
4000  CONTINUE
CDEL  IF (KC(68).NE.0) WRITE (SYSOUT,5305) EXES(2)                      00524*38
5305  FORMAT(///10H CLB0072--, A1, 66H FILL HEIGHT EXCEEDS STANDARD LIMI00525*31
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     $T, COST COMPUTED ON THE BASIS OF  /                                00526*31
     1          10X,       30HMAXIMUM FILL HEIGHT STRUCTURE.  )          00527*31
      GO TO 200                                                          00528
C                                                                        00529
C     CULVERT ANALYSIS STRAIGHT ARCH OR OVAL                             00530
C                                                                        00531
3200  GO TO (2301,3202,3203), INLET                                      00532
      GO TO 2106                                                         00533
3202  CALL RC44                                                          00534
      GO TO 203                                                          00535
 3203 CALL RC43(BWHEL,*1603)                                             00536*41
      GO TO 3106                                                         00537
3204  GO TO (2301,3206,3207), INLET                                      00538
      GO TO 2106                                                         00539
3206  CALL RC46                                                          00540
      GO TO 203                                                          00541
3207  CALL RC45                                                          00542
      GO TO 203                                                          00543
C                                                                        00544
C     STRAIGHT BOX                                                       00545
C                                                                        00546
3300  GO TO (3301,3302,3303), INLET                                      00547
      GO TO 2106                                                         00548
3301  CALL RC48                                                          00549
      GO TO 203                                                          00550
3302  CALL RC49                                                          00551
      GO TO 203                                                          00552
3303  CONTINUE
      IF(IGATE.EQ.0)CALL RC47   (BWHEL,*1603)                            00553*47
      IF(IGATE.EQ.1)CALL RC47FLP(BWHEL,*1603)
      IF(IGATE.EQ.2)CALL RC47FLP(BWHEL,*1603)
C3303 CALL RC47 (BWHEL,*1603)                                             00553*47
      GO TO 3106                                                         00554
C                                                                        00555
C     BROKEN-BACK ARCH                                                   00556
C                                                                        00557
3400  GO TO (3401,3405,3500,3504), SHAPE                                 00558
CDEL  WRITE (SYSOUT,46)                                                  00559
      GO TO 1603                                                         00560
3401  GO TO (3402,3403,3404), INLET                                      00561
      GO TO 2106                                                         00562
3402  CALL RC51                                                          00563
      GO TO 203                                                          00564
3403  CALL RC52                                                          00565
      GO TO 203                                                          00566
 3404 CALL RC50(BWHEL,*203)                                              00567*41
      GO TO 3110                                                         00568
3405  GO TO (2301,3407,3408), INLET                                      00569
      GO TO 2106                                                         00570
3407  CALL RC54                                                          00571
      GO TO 203                                                          00572
3408  CALL RC53                                                          00573
      GO TO 203                                                          00574
C                                                                        00575
C     BROKEN-BACK OVAL OR BOX                                            00576
C                                                                        00577
3500  GO TO (2301,3502,3503), INLET                                      00578
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      GO TO 2106                                                        00579
3502  CALL RC56                                                         00580
      GO TO 203                                                         00581
3503  CALL RC55                                                         00582
      GO TO 203                                                         00583
3504  GO TO (3505,3506,3507), INLET                                     00584
      GO TO 2106                                                        00585
3505  CALL RC58                                                         00586
      GO TO 203                                                         00587
3506  CALL RC59                                                         00588
      GO TO 203                                                         00589
 3507 CALL RC57(BWHEL,*203)                                             00590*41
      GO TO 3110                                                        00591
C                                                                       00592
C     ANALYZE STEPPED CIRCULAR OR ARCHED CULVERT                        00593
C                                                                       00594
3600  GO TO (3601,3605,3700,3704), SHAPE                                00595
CDEL  WRITE (SYSOUT,46)                                                 00596
      GO TO 1603                                                        00597
3601  GO TO (3602,3603,3604), INLET                                     00598
      GO TO 2106                                                        00599
3602  CALL RC61                                                         00600
      GO TO 203                                                         00601
3603  CALL RC62                                                         00602
      GO TO 203                                                         00603
3604  CALL RC60                                                         00604
      GO TO 203                                                         00605
3605  GO TO (2301,3606,3607), INLET                                     00606
      GO TO 2106                                                        00607
3606  CALL RC64                                                         00608
      GO TO 203                                                         00609
3607  CALL RC63                                                         00610
      GO TO 203                                                         00611
C                                                                       00612
C     ANALYZE STEPPED OVAL OR BOX CULVERT                               00613
C                                                                       00614
3700  GO TO (2301,3701,3702), INLET                                     00615
      GO TO 2106                                                        00616
3701  CALL RC66                                                         00617
      GO TO 203                                                         00618
3702  CALL RC65                                                         00619
      GO TO 203                                                         00620
3704  GO TO (3705,3706,3707), INLET                                     00621
      GO TO 2106                                                        00622
3705  CALL RC68                                                         00623
      GO TO 203                                                         00624
3706  CALL RC69                                                         00625
      GO TO 203                                                         00626
3707  CALL RC67                                                         00627
  203 CONTINUE
CDEL  CALL PAGE                                                         00628*43
  200 IF(KC(27).EQ.1) CALL RC99(INSTA1,OUTST1,INEL1,OUTEL1,*1603)       00629*47
  201 IF (KC(2).EQ.1) GO TO 3730                                        00630*46
      DIAM=0.                                                           00631*32
      DIFT=0.                                                           00632*46
      WIDE=0.                                                           00633*32
      HIGH=0.                                                           00634*32
```

```
 3730 IF(KC(25).EQ.0) GO TO 3740                                        00635*34
      WATEL=0.0                                                         00636*34
      KC(25)=0                                                          00637*34
 3740 RETURN                                                            00638*34
      END                                                               00639
      SUBROUTINE IINDEX(J,HIFT,ITYP)                                    00001**6
      DIMENSION RISE(16)                                                00002
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00003
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00004
      DATA RISE/0.938,1.25,1.67,2.00,2.42,2.75,3.17,3.58,3.92,4.58,     00006**7
     1 5.33,5.66,6.00,6.33,6.67,7.00/                                   00007**7
C                                                                       00008
C ROUTINE TO CALCULATE INDEX NUMBER FOR PRICE ARRAY FROM CULVERT CHARACT00009
C                                                                       00010
C  ITYP=1  FOR  CONC CIRC PIPE                                          00011
C  ITYP=2  FOR  CGM  CIRC PIPE                                          00012
C  ITYP=3  FOR  FLARE UNIT                                              00013
C  ITYP=4  FOR  CONC ARCH PIPE                                          00014
C  ITYP=5  FOR  CGM  ARCH PIPE                                          00015
      IF (ITYP.GT.3) GO TO 20                                           00016
      J=(ITYP-1)*21                                                     00017
      IF(HIFT.GT.3.) GO TO 11                                           00018**6
      J=J+4.*(HIFT-1.25)                                                00019**6
      GO TO 30                                                          00020
  11  J=J+7.+(HIFT-3.00)*2.                                             00021**6
      GO TO 30                                                          00022
20    NR=11+(ITYP-4)*5                                                  00023
      JK=63+(ITYP-4)*11                                                 00024
      J=JK                                                              00025
C                                                                       00026
C LOOP TO CORRELATE GIVEN DIMENSION WITH STANDARD                       00027
C                                                                       00028
      DIF=100.                                                          00029
      DO 21 K=1,NR                                                      00030
      TDIF=ABS(HIFT-RISE(K))                                            00031**6
      IF(TDIF.GT.0.16.OR.TDIF.GT.DIF)GO TO 21                           00032**2
      J=JK+K                                                            00033
      DIF=TDIF                                                          00034
21    CONTINUE                                                          00035
      IF (J.NE.JK) GO TO 30                                             00036
CDEL  WRITE (SYSOUT,1000)                                               00037
 1000 FORMAT (' CLB0104A--NOMINAL DIMENSIONS GIVEN DO NOT AGREE WITH',  00038**6
     .' STANDARD DIMENSIONS.')                                          00039**6
30    RETURN                                                            00040
      END                                                               00041
      SUBROUTINE AREAH                                                   00001
      COMMON/ARCHP/A1,AK1,AK2,ALPHA,ARC,B,BETA,D1,D3,D5,H1,H2,H3,R1,R2, 00002
     1 R3,W,WPR                                                         00003
C                                                                       00004
C AREA COMPUTES CROSS SECTIONAL AREA AT A GIVEN DEPTH FOR ARCH PIPE     00005
C                                                                       00006
C                                                                       00007
C  THE ARCH PIPE WAS DIVIDED INTO 4 AREAS BY HEIGHT AND A FORMULA FOR EA00008
C AREA DERIVED.  THESE ARE STATEMENTS 1,2,3, AND 6 PLUS ONE             00009
C                                                                       00010
      HT1=H1                                                            00011
      HT2=H2                                                            00012
```

```
      HT3=H3                                                            00013
      IF (D5.GE.H1) GO TO 1                                             00014
      H1=D5                                                             00015
1     ARC=R1**2*(1.5708-ARSIN((R1-H1)/R1)-(R1-H1)*SQRT(2.*R1*H1-H1**2)  00016
     1 /R1**2)                                                          00017
      IF (D5.LE.H1) GO TO 4                                             00018
      IF (D5.GE.(H1+H2)) GO TO 2                                        00019
      H2=D5-H1                                                          00020
2     ARC=ARC+R3**2*(ARSIN(D1/R3)-ARSIN((D1-H2)/R3))+D1*SQRT(R3**2-D1**200021
     1 )-(D1-H2)*SQRT(R3**2-(D1-H2)**2)-AK1*H2*(2.*D1-H2)+H2*(A1+(R1-H1 00022
     2 -H2)*AK1)                                                        00023
      IF (D5.LE.(H1+H2)) GO TO 4                                        00024
      IF (D5.GE.(H1+H2+H3)) GO TO 3                                     00025
      H3=D5-(H1+H2)                                                     00026
      IF (H3.LE.R3) GO TO 3                                             00027
      H3=R3                                                             00028
3     ARC=ARC+R3**2*(ARSIN(H3/R3)+H3*SQRT(R3**2-H3**2)/R3**2)-AK2*H3**2 00029
     1 +H3*(W+AK2*H3)                                                   00030
      IF (D5.LE.(H1+H2+H3)) GO TO 4                                     00031
      H4=D5-(H1+H2+H3)                                                  00032
      IF ((D3+H4).GT.R2) H4=R2-D3                                       00033
      IF (D3.GT.R2) D3=R2                                               00034
      ANGS=AMIN1((D3+H4)/R2,9.999999E-1)                                00035**4
      ARC=ARC+R2**2*(ARSIN(ANGS)-ARSIN(D3/R2))+(D3+H4)*SQRT(R2**2       00036
     1 -(D3+H4)**2)-D3*SQRT(R2**2-D3**2)                                00037
4     H1=HT1                                                            00038
      H2=HT2                                                            00039
      H3=HT3                                                            00040
      RETURN                                                            00041
      END                                                               00042
      SUBROUTINE BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)        00001**4
C                                                                       00002
C       ROUTINE SOLVES FOR THE UNIFORM DEPTH OF FLOW IN A GIVEN CULVERT 00003
C          A GIVEN DISCHARGE AND A GIVEN SLOPE. VARIABLE NAME UDEP      00004
C                                                                       00005
      COMMON/ARCHP/A1,AK1,AK2,ALPHA,ARC,X,BETA,D1,D3,D5,H1,H2,H3,R1,R2, 00006
     1 R3,W,WPR                                                         00007
      REAL MANN                                                         00008
      INTEGER SHAPE                                                     00009
      SLOP(A,B,C,D)=A**2*B**2/(2.208*C**2*D**(4./3.))                   00010
      GO TO (1,2,12,4), SHAPE                                           00011
    1 THIGH=DIFT*.93818                                                 00012**4
      HIMAX=DIFT                                                        00013**4
      GO TO 5                                                           00014
    2 THIGH=HIFT*.9257                                                  00015**4
      HIMAX=HIFT                                                        00016**4
      GO TO 5                                                           00017
   4  THIGH=HIFT                                                        00018**4
      HIMAX=HIFT                                                        00019**4
5     D5=THIGH/2.                                                       00020
      DENOM=4.                                                          00021
6     GO TO (7,8,12,10), SHAPE                                          00022
    7 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00023**4
      GO TO 11                                                          00024
8     CALL AREAH                                                         00025
      CALL WETPR                                                        00026
      R=ARC/WPR                                                         00027
```

```
      S=SLOP(QPP,MANN,ARC,R)                                            00028
      GO TO 11                                                          00029
   10 A=WIFT*D5                                                         00030**4
      WP=WIFT+2.*D5                                                     00031**4
      R=A/WP                                                            00032
      S=SLOP(QPP,MANN,A,R)                                              00033
11    IF (S.GT.SLOPE) GO TO 13                                          00034
      D5=D5-THIGH/DENOM                                                 00035
      GO TO 14                                                          00036
13    D5=D5+THIGH/DENOM                                                 00037
14    IF (THIGH/DENOM.LT.0.005) GO TO 12                                00038
      DENOM=DENOM*2.                                                    00039
      GO TO 6                                                           00040
12    UDEP=D5                                                           00041
      IF ((THIGH-UDEP).LT.0.005) UDEP=HIMAX                             00042
      RETURN                                                            00043
      END                                                               00044
      SUBROUTINE BOXQ (F,CULCOS)                                        00001
      DIMENSION SSB(86),SMB(87),SAB(87),NPROD(34)                       00002
      REAL MANN,INEL,KECF,LEN,LFTSS,LENGTH                              00003**8
      INTEGER SHAPE,PROFIL,OPENGS                                       00004**4
      COMMON/COSCOM/PRC(90),CONC,STL,FILLH,CMISC,COSFT,TOTCOS           00005
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00006**3
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00007**7
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00008**3
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00009**3
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00010**4
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00012
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00013
      DATA SSB/26.92,37.06,28.70,44.87,39.35,46.87,42.98,58.70,50.21,   00014
     162.69,62.50,63.66,66.32,76.53,76.92,76.76,79.88,91.22,79.65,108.9900015
     2,94.78,85.22,127.67,112.83,101.02,132.13,119.33,108.74,139.27,128.00016
     347,153.15,134.81,160.05,166.95,60.70,0.0,67.58,64.72,0.0,66.94,78.00017
     495,83.08,80.97,85.65,94.74,88.61,119.82,98.30,98.23,133.15,124.29,00018
     5107.96,141.61,131.42,116.82,149.03,141.10,159.89,148.52,167.62,18600019
     6.66,78.84,0.0,0.0,83.12,0.0,97.05,97.92,0.0,109.43,101.94,130.39,100020
     713.45,111.76,154.99,135.13,123.30,164.30,146.43,132.15,172.36,152.00021
     812,178.80,165.09,192.24,211.62/                                   00022
      DATA NPROD/6,8,9,10,12,15,16,18,20,21,24,25,28,30,32,35,36,40,42,400023
     15,48,49,50,54,56,60,63,64,70,72,80,81,90,100/                     00024
      DATA SMB/77.23,0.0,80.38,0.0,97.30,86.13,103.63,103.31,103.93,109.00025
     166,121.43,129.47,127.76,125.66,147.99,132.00,161.02,153.33,140.24,00026
     20.0,166.27,161.86,182.30,174.79,172.78,193.40,188.14,201.00,197.0400027
     3,214.42,232.04,69.41,0.0,72.34,0.0,103.08,77.96,106.61,109.38,95.400028
     40,112.61,127.68,129.27,130.65,132.20,147.65,135.62,157.26,152.16,100029
     543.86,0.0,168.11,160.69,195.25,176.81,171.53,206.01,187.73,214.04,00030
     6196.64,230.39,249.08,120.91,0.0,0.0,127.06,0.0,148.52,145.34,0.0,100031
     767.37,150.69,175.98,172.27,163.64,0.0,188.28,184.60,209.68,197.19,00032
     8190.41,224.09,213.87,230.28,223.31,247.46,270.16/                 00033
      DATA SAB/36.63,0.0,37.96,0.0,46.69,40.74,49.34,49.37,45.25,52.01,500034
     14.01,61.24,56.67,55.36,66.02,58.01,74.88,68.10,60.73,0.0,76.95,70.00035
     277,83.58,79.62,72.43,86.92,82.79,88.51,85.46,92.57,96.40,35.51,0.000036
     3,36.85,0.0,53.64,39.52,55.63,56.32,44.09,58.32,60.93,66.66,62.95,600037
     42.27,71.31,65.02,76.52,72.65,67.69,0.0,79.82,75.32,94.82,82.50,76.00038
     585,97.50,86.48,99.09,89.15,103.07,106.86,65.84,0.0,0.0,68.51,0.0,700039
     68.37,73.18,0.0,83.05,75.48,88.38,84.38,78.16,0.0,92.78,87.06,102.300040
     77,95.45,88.61,105.15,99.91,106.82,102.58,109.49,114.02/           00041
```

```
      IPROD=WIFT*HIFT
      IF (BBLS.EQ.0.) GO TO 406
      IF (BBLS.GT.1.) GO TO 300
C
C FIND J
C
      IW=WIFT-2.
      GO TO (104,105,106,107),IW
      IF (F.LE.6.) GO TO 110
      IF (F.LE.8.) GO TO 111
      IF (F.GT.10.) GO TO 108
      J=3
      GO TO 109
104   IF (F.GT.14.) GO TO 108
110   J=1
      GO TO 109
105   IF (F.LE.12.) GO TO 110
108   KC(68)=1
      IF (IPROD.LT.21) GO TO 115
      J=3
      IF(BBLS.GT.1.AND.WIFT.LT.7.0) J=2
      IF (BBLS.EQ.1) GO TO 109
      GO TO 303
106   IF (F.GT.8.) GO TO 108
      GO TO 110
107   IF (F.LE.8.) GO TO 110
      IF (F.GT.10.) GO TO 108
111   J=2
      IF (IPROD.LT.18) GO TO 115
C
C FIND STEEL QUANTITY PER FOOT (STLFT)
C
109   DO 113 JA=1,34
      IF (IPROD.EQ.NPROD(JA)) GO TO 114
113   CONTINUE
  115 CONTINUE
CDEL  WRITE (SYSOUT,1002) BBLS,WIFT,HIFT,LENGTH,F
      CULCOS=1.0E10
       GO TO 406
114   IF (J.EQ.2) JA=JA+27
      IF (J.EQ.3) JA=JA+52
      STLFT=SSB(JA)
      IF (STLFT.EQ.0.0) GO TO 115
C
C FIND THICKNESS FOR TOP AND BOTTOM OF BOX (T) AND SIDES (U)
C
      IF(WIFT.GT.7.) GO TO 201
      T=6.0
      IF(WIFT.EQ.7.) T = T+0.5
      GO TO 202
201   GO TO (203,204), J
      T = 7.+(WIFT-7.)*0.5
      GO TO 202
  203 T=6.5 + IFIX ((WIFT-7.)*0.6)
      GO TO 202
  204 T=IFIX(7.+(WIFT-7.)*0.49)
  202 U=IFIX(5.5+HIFT*0.33)
```

```
C
C COMPUTE QUANTITIES FOR SINGLE BOX
C
      STLQ=LENGTH*STLFT*STL
      AREA=2.*WIFT*T/12.+2.*(HIFT+2.*T/12.)*U/12.
      CONQ=AREA*LENGTH/27.*CONC
      GO TO 405
C
C MULTIPLE BARREL QUANTITIES
C
C
C FIND J
C
  300 IF(WIFT.GT.6.) GO TO 301
      IF (F.GT.4.) GO TO 302
304   J=1
      GO TO 303
302   IF (F.GT.6.) GO TO 108
305   J=2
      GO TO 303
301   IF (F.LE.2.) GO TO 304
      IF (F.LE.4.) GO TO 305
      IF (F.LE.6.) GO TO 306
      GO TO 108
306   J=3
C
C FIND STEEL QUANTITY PER FOOT OF CULVERT
303   DO 307 JA=1,34
      IF (IPROD.EQ.NPROD(JA)) GO TO 308
307   CONTINUE
      GO TO 115
308   IF (J.EQ.1) JA=JA-3
      IF (J.EQ.2) JA=JA+28
      IF (J.EQ.3) JA=JA+53
      STLFT=SMB(JA)
      STADD=SAB(JA)
C
C FIND THICKNESS FOR TOP AND BOTTOM OF BOX (T) AND SIDES (U)
C
      IF(WIFT.GT.7) GO TO 401
      T=6.0
      IF(WIFT.EQ.7.) T=T+0.5
      GO TO 402
401   GO TO (403,404), J
      T=6.5+(WIFT-7.)*1.0
      GO TO 402
  403 T=6.5+((WIFT-8.)*0.5)
      GO TO 402
  404 T=IFIX(7.6+(WIFT-7.)*0.3)
      IF(WIFT.EQ.10.) T=T+0.5
  402 U=IFIX(5.5+HIFT*0.33)
C
C COMPUTE STEEL AND CONCRETE QUANTITIES FOR MULTIPLE BOX
C
      STLFT=STLFT+STADD*(BBLS-2.)
      STLQ=STLFT*LENGTH*STL
      AREA=(((BBLS+1.)*U/12.+BBLS*WIFT)*T/12.)*2.+(BBLS+1.)*HIFT*U/12.
```

```
      CONQ=AREA*LENGTH/27.*CONC
405   CONTINUE
      CULCOS=STLQ+CONQ
406   CONTINUE
1002  FORMAT (  36H CLB0073--NO STANDARD AVAILABLE FOR , F3.0, 1H-, F3.0
     $, 1HX, F3.0, 1HX, F4.0,  19H     FILL HEIGHT = , F4.1 )
      RETURN
      END
      SUBROUTINE BWM1(SHAPE,TW,DIFT,WIFT,QPP,MANN,SLOPE,LENGTH,UDEP,
     1 WDEP)
      COMMON/ARCHP/A1,AK1,AK2,ALPHA,ARC,B,BETA,D1,D3,D5,H1,H2,H3,R1,R2,
     1 R3,W,WPR
      INTEGER SHAPE
      REAL MANN,LENGTH
      SLOP(A,B,C,D)=A**2*B**2/(2.208*C**2*D**(4./3.))
C
C BWM1 CALCULATES THE WATER SURFACE PROFILE USING THE M1 CURVE
C WHICH IS FOR A MILD SLOPE CHANNEL WHERE THE BEGINNING DEPTH (DOWNSTREA
C IS GREATER THAN UNIFORM DEPTH
C
C
      DIST=0.
      D5=TW
1      GO TO (6,7,8,9), SHAPE
   6  CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)
      GO TO 10
7     CALL AREAH
      CALL WETPR
      R=ARC/WPR
      S=SLOP(QPP,MANN,ARC,R)
      A=ARC
      GO TO 10
8     GO TO 11
   9  A=WIFT*D5
      WP=WIFT+2.*D5
      R=A/WP
      S=SLOP(QPP,MANN,A,R)
10    V=QPP/A
      HENEW=D5+V**2/64.4
      SFNEW=S
      IF (D5.EQ.TW) GO TO 2
      DELH=HENEW-HEOLD
      DELS=SLOPE-(SFNEW+SFOLD)/2.
      DIST=DIST+ABS(DELH/DELS)
      IF (DIST.GE.LENGTH) GO TO 3
      IF (D5.LE.UDEP) GO TO 4
2     D5=D5-0.01
      SFOLD=SFNEW
      HEOLD=HENEW
      GO TO 1
3     WDEP=D5
      GO TO 11
4     WDEP=UDEP
11    RETURN
      END
      SUBROUTINE BWM2(TW,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLOPE,LENGTH,
     . UDEP,WDEP,D5,DIST,HIFT)
```

```
      COMMON/ARCHP/A1,AK1,AK2,ALPHA,ARC,B,BETA,D1,D3,DJ,H1,H2,H3,R1,R2,
     1 R3,W,WPR
      INTEGER SHAPE
      REAL LENGTH,MANN
      SLOP(A,B,C,D)=A**2*B**2/(2.208*C**2*D**(4./3.))
C
C BWM2 CALCULATES THE WATER SURFACE PROFILE USING THE M2 CURVE
C WHICH IS FOR A MILD SLOPE CHANNEL WHERE THE BEGINNING DEPTH (DOWNSTREA
C IS LESS THAN UNIFORM DEPTH BUT NOT LESS THAN CRITICAL DEPTH
C
C
      DIST=0.
      IF (TW.GT.CRITD) GO TO 1
      STAR=CRITD
      D5=CRITD
      GO TO 2
1     STAR=TW
      D5=TW
2     GO TO (8,9,10,11), SHAPE
    8 CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)
      GO TO 12
9     DJ=D5
      CALL AREAH
      CALL WETPR
      R=ARC/WPR
      S=SLOP(QPP,MANN,ARC,R)
      A=ARC
      GO TO 12
10    GO TO 7
   11 A=WIFT*D5
      WP=WIFT+2.*D5
      R=A/WP
      S=SLOP(QPP,MANN,A,R)
12    V=QPP/A
      HENEW=D5+V**2/64.4
      SFNEW=S
      IF (D5.EQ.STAR) GO TO 3
      DELH=HENEW-HEOLD
      DELS=SLOPE-(SFNEW+SFOLD)/2.
      DIST=DIST+ABS(DELH/DELS)
      IF (DIST.GE.LENGTH) GO TO 4
      GO TO (13,14,15,16), SHAPE
   13 IF(D5.GT.(0.93*DIFT)) GO TO 5
      GO TO 17
   14 IF(D5.GT.0.9257*HIFT) GO TO 5
      GO TO 17
15    GO TO 7
   16 IF(D5.GE.HIFT) GO TO 5
17    IF (D5.GE.UDEP) GO TO 6
3     D5=D5+0.01
      HEOLD=HENEW
      SFOLD=SFNEW
      GO TO 2
4     WDEP=D5
      GO TO 7
5     GO TO (18,19,20,21), SHAPE
   18 WDEP=DIFT
```

```
      GO TO 7                                                           00060
   19 WDEP=HIFT                                                         00061**5
      GO TO 7                                                           00062
20    GO TO 7                                                           00063
   21 WDEP=HIFT                                                         00064**5
      GO TO 7                                                           00065
6     IF(SHAPE.EQ.4) GO TO 25                                           00066**2
      IF(UDEP.GT.(0.93*DIFT)) GO TO 5                                   00067**5
25    WDEP=UDEP                                                         00068**2
7     RETURN                                                            00069
      END                                                               00070
      SUBROUTINE BWM3(SHAPE,QPP,MANN,WIFT,DC,SLP,DSTAR,LENB,WATEL,OUTEL,00001**4
     . HIFT,K,NUNITS,DLAST)                                             00002**4
      REAL MANN,LENB                                                    00003
      INTEGER SHAPE                                                     00004
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00005
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00006
C                                                                       00007
C BWM3 CALCULATES THE WATER SURFACE PROFILE USING THE M3 CURVE          00008
C                                                                       00009
      D5=DSTAR                                                          00010
      TW=WATEL-OUTEL                                                    00011
      DIST=0.                                                           00012
10    GO TO (11,80,80,12), SHAPE                                        00013
  11  CALL CIRCLE (D5,A,S,HIFT,QPP,MANN)                                00014**4
      GO TO 13                                                          00015
  12  A=WIFT*D5                                                         00016**4
      WP=WIFT+2.*D5                                                     00017**4
      R=A/WP                                                            00018
      S=QPP*QPP*MANN*MANN/(2.208*A*A*R**1.333333)                       00019
13    V=QPP/A                                                           00020
      HENEW=D5+V*V/64.4                                                 00021
      SFNEW=S                                                           00022
      GO TO (14,80,80,15), SHAPE                                        00023
  14  CALL JUMP (D5,HIFT,QPP,D2,DC,MANN)                                00024**4
      GO TO 20                                                          00025
15    D2=-D5/2.+SQRT(2.*QPP*QPP*D5/(32.2*A*A)+D5*D5/4.)                 00026
      IF(D2.LE.HIFT) GO TO 20                                           00027**4
      Y1=D5/2.                                                          00028
      A2=HIFT*WIFT                                                      00029**4
      D2=(QPP*QPP/32.2*(1./A-1./A2)+A*Y1)/A2+HIFT/2.                    00030**4
20    IF(D5.EQ.DSTAR)GO TO 40                                           00031
      DELH=HENEW-HEOLD                                                  00032
      DELS=SLP-(SFNEW+SFOLD)/2.                                         00033
      DIST=DIST+ABS(DELH/DELS)                                          00034
      GO TO (22,22,24),K                                                00035
22    IF(NUNITS.NE.2)GO TO 28                                           00036
24    IF(D2.GT.TW)GO TO 28                                              00037
      KC(54)=1                                                          00038
      IF(TW.GT.HIFT) GO TO 26                                           00039**4
      DLAST=TW                                                          00040
      GO TO 80                                                          00041
  26  DLAST=HIFT                                                        00042**4
      GO TO 80                                                          00043
28    IF(D5.LT.DC)GO TO 30                                              00044
      DLAST=DC                                                          00045
      IF (NUNITS.NE.3.OR.K.NE.2) KC(54)=1                               00046
```

```
      IF (KC(53).EQ.1) KC(54)=1
      GO TO 80
30    IF(DIST.GE.LENB)GO TO 32
40    SFOLD=SFNEW
      HEOLD=HENEW
      D5=D5+0.01
      GO TO 10
32    DLAST=D5
80    RETURN
      END
      SUBROUTINE BWS2 (SHAPE,DIFT,QPP,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,
     1 D5,*)
      COMMON/ARCHP/A1,AK1,AK2,ALPHA,ARC,B,BETA,D1,D3,DJ,H1,H2,H3,R1,R2,
     1 R3,W,WPR
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
      REAL MANN,LENGTH
      INTEGER SHAPE
      SLOP(A,B,C,D)=A**2*B**2/(2.208*C**2*D**(4./3.))
C
C BWS2 CALCULATES THE WATER SURFACE PROFILE USING THE S2 CURVE
C WHICH IS FOR A STEEP SLOPE CHANNEL WHERE THE BEGINNING DEPTH (UPSTREAM
C IS USUALLY CRITICAL DEPTH
C
C
      DIST=0.
      D5=CRITD
1     GO TO (4,5,6,7), SHAPE
 4    CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)
      GO TO 8
5     DJ=D5
      CALL AREAH
      CALL WETPR
      R=ARC/WPR
      S=SLOP(QPP,MANN,ARC,R)
      A=ARC
      GO TO 8
6     GO TO 9
 7    A=WIFT*D5
      WP=WIFT+2.*D5
      R=A/WP
      S=SLOP(QPP,MANN,A,R)
8     V=QPP/A
      HENEW=D5+V**2/64.4
      SFNEW=S
      IF (D5.EQ.CRITD) GO TO 2
      DELH=HENEW-HEOLD
      DELS=SLOPE-(SFNEW+SFOLD)/2.
      DIST=DIST+ABS(DELH/DELS)
      IF (DIST.GE.LENGTH.OR.D5.LE.UDEP) GO TO 9
2     D5=D5-0.01
      SFOLD=SFNEW
      HEOLD=HENEW
      IF(D5.GT.0.0) GO TO 1
      KC(56) = 1
CDEL  WRITE (SYSOUT,8001)
 8001 FORMAT (' CLB0113--PRIOR RESULTS OK. NO SOLUTION FOUND FOR ',
```

```
     1 'SUCCEEDING COMPUTATIONS BECAUSE DISCHARGE RESULTS IN TOO LOW',
     2 ' A VALUE FOR PROPER BACKWATER DETERMINATION')
      RETURN 1
9     RETURN
      END
      SUBROUTINE BWS3 (SHAPE,QPP,MANN,WIFT,SLP,DSTAR,LENB,HIFT,DIFT,
     1 DLAST)
      REAL MANN,LENB
      INTEGER SHAPE
C
C BWS3 CALCULATES THE WATER SURFACE PROFILE USING THE S3 CURVE
C
      D5=DSTAR
      DIST=0.
      CALL BOXUD (SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP,UDEP)
10    GO TO (20,80,80,30), SHAPE
   20 CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)
      GO TO 40
   30 A=WIFT*D5
      WP=WIFT+2.*D5
      R=A/WP
      S=QPP*QPP*MANN*MANN/(2.208*A*A*R**1.333333)
40    V=QPP/A
      HENEW=D5+V*V/64.4
      SFNEW=S
      IF(D5.EQ.DSTAR)GO TO 60
      DELH=HENEW-HEOLD
      DELS=SLP-(SFNEW+SFOLD)/2.
      DIST=DIST+DELH/DELS
      IF(D5.GE.UDEP)GO TO 70
      IF(DIST.GE.LENB)GO TO 70
60    SFOLD=SFNEW
      HEOLD=HENEW
      D5=D5+0.01
      GO TO 10
70    DLAST=D5
80    RETURN
      END
      SUBROUTINE CIRCLE(D5,A,S,DIFT,QPP,MANN)
      REAL MANN
C
C CIRCLE COMPUTES CROSS SECTIONAL AREA AND ASSOCIATED MANNINGS FORMULA
C SLOPE FOR ANY DEPTH IN A CIRCULAR PIPE
C
  100 VAL=(2.*D5-DIFT)/DIFT
      IF (ABS(VAL).LT.1.) GO TO 20
      THETA=0.
      GO TO 21
20    THETA=2.*ARCOS(VAL)
   21 A=DIFT**2./8.*(6.2832-THETA+SIN(THETA))
      AK=1.486*((((6.2832-THETA+SIN(THETA))/8.)**5)/(((6.2832-THETA)
     1 /2.)**2*(D5/DIFT)**8))**(1./3.)
      S=(QPP*MANN/(AK*D5**(8./3.)))**2
      RETURN
      END
      SUBROUTINE CNVYCU(X,Y,NPTS,CON,AR,N,IU)
      DIMENSION X(120),Y(120)
```

```
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,
     1   LENGTH
      INTEGER SHAPE,PROFIL,OPENGS
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE
      COMMON/CCOM1/BRSUB(10),CLVTID,FLSEC,NAME,ORIGID,ROADID
      COMMON/ID/MOVEID,TOID,GSEC(50),CONYID,NAM,IS1,IS2,IDSEC(50)
      CHARACTER*3 CLVTID,BRSUB,NAME,ROADID
      CHARACTER*4 A4BLNK,FLSEC,ORIGID,MOVEID,TOID,GSEC,CONYID,NAM,IS1,
     1 IS2,IDSEC
      DATA A4BLNK/'    '/
C
C CNVYCU CALCULATES CONVEYANCE FOR GIVEN CROSS SECTION AND ROUGHNESS COE
C
C THE N VALUE REFERRED TO IN THE COMMENTS IS MANNINGS ROUGHNESS COEFFICI
C
      READ (A4BLNK,FMT='(A4)') RBLNK
      KFLG=1
      AR=0.
      HUD=WATEL
      CON=0.
      WP=0.
      AREA=0.
      K=1
      KOLD=0
      NN=NPTS+1
      DO 40 I=1,NN
      IF (I.NE.1) GO TO 2
      IF (KC(32).EQ.0) GO TO 40
C
C SET X'S AND Y'S FOR BEGINNING TRIANGULAR AREA FOR A BRIDGE
C
      Y1=WATEL
      X1=X(1)-AMAX1(LFTSS(N)*(WATEL-Y(1)),0.)
      Y2=Y(I)
      X2=X(I)
      GO TO 6
2     IF (I.NE.NPTS+1) GO TO 4
      IF (KC(32).EQ.0) GO TO 40
C
C SET X'S AND Y'S FOR ENDING TRIANGULAR AREA FOR A BRIDGE
C
      Y1=Y(NPTS)
      X1=X(NPTS)
      Y2=WATEL
      X2=X(NPTS)+AMAX1(RGTSS(N)*(WATEL-Y(NPTS)),0.)
      GO TO 6
C
C SET X'S AND Y'S FOR NORMAL CROSS-SECTION BREAK POINTS
C
```

```
4       X1=X(I-1)
        X2=X(I)
        Y1=Y(I-1)
        Y2=Y(I)
6      IF (K.EQ.KOLD) GO TO 9
C
C SET NEW N VALUES
C
       KOLD=K
        FROM=ISECN(IU,5*K-4)
        TO=ISECN(IU,5*K-3)
        BELOW=ISECN(IU,5*K-2)
        CHG=ISECN(IU,5*K-1)
        ABOVE=ISECN(IU,5*K)
       IF(FROM.NE.RBLNK) GO TO 8
        FROM=X1
        TO=X(NPTS)+AMAX1(RGTSS(N)*(WATEL-Y(NPTS)),0.)
  8    IF(CHG.EQ.RBLNK) CHG=HUD+1
C
C CHECK THAT X IS STILL IN RANGE OF THE CURRENT N VALUE LIMITS
C
9       IF(X1.GE.TO)GO TO 14
C
C CHECK THAT THE Y VALUES ARE BELOW THE WATER SURFACE
C
        IF(Y2.LT.HUD)GO TO 12
        IF(Y1.GE.HUD)GO TO 10
        X2=(HUD-Y1)/(Y2-Y1)*(X2-X1)+X1
        Y2=HUD
        GO TO 16
10      IF(X2.GE.TO) K=K+1
       GO TO 40
12      IF(Y1.LT.HUD)GO TO 16
C
C ESTABLISH VALUE FOR BEGINNING POINT OF TRAPEZOID
C
        XA=(Y1-HUD)/(Y1-Y2)*(X2-X1)+X1
        YA=HUD
        IF(XA.LT.TO)GO TO 18
  14     K=K+1
         GO TO 6
16      XA=X1
        YA=Y1
C
C ESTABLISH THE VALUE FOR THE END POINT OF THE TRAPEZOID
C
18      IF(X2-TO)21,22,20
20      KFLG=1
        XB=TO
        YB=(XB-X1)/(X2-X1)*(Y2-Y1)+Y1
        NEXT=2
        GO TO 26
21      IF(I.LT.NN)GO TO 24
22      KFLG=1
24      NEXT=1
        XB=X2
        YB=Y2
```

```
C                                                                       00118
C COMPUTE AREA AND WETTED PERIMETER OF THE TRAPEZOID                    00119
C                                                                       00120
26     B=XB-XA                                                          00121
       IF(B.LE.0.0)GO TO 40                                             00122
       WP=   SQRT(B*B+(YA-YB)**2)                                       00123**3
       X1=XB                                                            00124
       Y1=YB                                                            00125
C                                                                       00126
C CHANGE N TO COINCIDE WITH INPUT VALUES FOR CHANGE ABOVE AND BELOW AN  00127
C ELEVATION IF NECESSARY                                                00128
C                                                                       00129
       IF(WP.LT.0.001) GO TO 32                                         00130**3
      HI=AMAX1(YA,YB)                                                   00131**9
      AREA=B*ABS(YA-YB)/2.0+B*(HUD-HI)                                  00132**9
       IF(KFLG.EQ.0) GO TO 30                                           00133**3
       CHGL=CHG-.5                                                      00134
       CHGH=CHG+.5                                                      00135
       IF(HUD.GT.CHGL)GO TO 27                                          00136
       RUFNES=BELOW                                                     00137
       GO TO 29                                                         00138**3
27     IF(HUD.GE.CHGH)GO TO 28                                          00139
       RUFNES=(HUD-CHGL)*(ABOVE-BELOW)+BELOW                            00140
       GO TO 29                                                         00141**3
28     RUFNES=ABOVE                                                     00142
29     KFLG=0                                                           00143**3
      IF(X2.GE.TO) K = K+1                                              00144**5
C                                                                       00145
C CALCULATE THE CONVEYANCE FOR THIS N AND ACCUMULATE THE AREAS          00146
C                                                                       00147
30     R=AREA/WP                                                        00148
       CON=1.486/RUFNES*R**.6666667*AREA+CON                            00149
       AR=AR+AREA                                                       00150
32     GO TO(40,6),NEXT                                                 00151
40    CONTINUE                                                          00152
      RETURN                                                            00153
      END                                                               00154
      SUBROUTINE COST                                                   00001
      REAL MANN,INEL,KECF,LEN,LFTSS,LENGTH                              00002**7
      INTEGER SHAPE,PROFIL,OPENGS                                       00003**3
      COMMON/COSCOM/PRC(90),CONC,STL,FILLH,CMISC,COSFT,TOTCOS           00004
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00005**2
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00006**6
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00007**2
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00008**2
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00010**3
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00011
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00012
C                                                                       00013
C ROUTINE TO CALCULATE CULVERT COST                                     00014
C                                                                       00015
      IF (KC(62).NE.1) GO TO 101                                        00016
C                                                                       00017
C BOX CULVERT COST COMPUTATION                                          00018
C                                                                       00019
      CULCOS=LENGTH*COSFT                                               00020
      GO TO 105                                                         00021
```

```
101   IF (FILLH.NE.0.0) GO TO 102
103   TOTCOS=1.0E10
      GO TO 106
C
C BOX COST USING CONCRETE AND STEEL QUANTITIES FROM BOXQ
C
  102 FILUSE=FILLH-HIFT-0.5
      CALL BOXQ (FILUSE,CULCOS)
105   TOTCOS=CULCOS+CMISC
106   RETURN
      ENTRY PIPCOS(J)
C
C COST CALCULATION FOR OTHER THAN BOX CULVERT
C
      IF (MAT.EQ.3) GO TO 103
      CULCOS=BBLS*LENGTH*PRC(J)
C
C INLET=1 FOR FLARE CULVERT
C
      IF(INLET.EQ.1) CULCOS=CULCOS+PRC(KC(63))*BBLS-1.5*DIFT*BBLS
     1*PRC(J)
      GO TO 105
      END
      SUBROUTINE CRITIC(QPP,DIFT,CRITD,CRSLPE,MANN)
      REAL MANN
C
C CRITIC DETERMINES CRITICAL DEPTH AND CRITICAL SLOPE FOR A GIVEN
C CIRCULAR PIPE DIAMETER, ROUGHNESS COEFFICIENT, AND DISCHARGE PER BARRE
C
      ONE=QPP**2/32.2
      D5=DIFT/2.-0.01
      DENOM=2.
  1   IF(DIFT/DENOM.LT.0.005) GO TO 3
      CALL CIRCLE(D5,A,CRSLPE,DIFT,QPP,MANN)
      TWO=A**3/(2.*SQRT(D5*DIFT-D5*D5))
      DENOM=DENOM*2.
      IF (ONE-TWO) 2,3,4
  2   D5=D5-DIFT/DENOM
      GO TO 1
  4   D5=D5+DIFT/DENOM
      GO TO 1
3     CRITD=D5
      RETURN
      END
      SUBROUTINE JUMP(D5,DIFT,QPP,D2,CRITD,MANN)
      REAL MANN
C
C FUNCT IS THE CALCULATION FOR THE DISTANCE FROM THE CENTER OF A CIRCLE
C TO THE CENTER OF GRAVITY AT A GIVEN DEPTH.  (NEGATIVE)
C
      FUNCT (A,B,C)=((-8.*(A**2/4.-B**2)**1.5)/(3.*A**2))/(C+2.*B*SQRT
     1 (A**2-4.*B**2)/A**2+1.57079)
C
C JUMP CALCULATES THE THEORETICAL CONJUGATE (OR SEQUENT) DEPTH FOR A GIV
C INITIAL DEPTH IN A HYDRAULIC JUMP FOR CIRCULAR CULVERTS BY SOLVING THE
C EQUATION OF PRESSURE PLUS MOMENTUM USING A CONVERGENCE PROCESS
C
```

```
      DEP=D5-DIFT/2.
      DSTORE=D5
      DENOM=2.
      IF (DEP.LT.0.0) GO TO 110
      PHI=ARSIN(2.*DEP/DIFT)
      GO TO 120
  110 PHI=-ARSIN(-2.*DEP/DIFT)
C
C SOLVE FOR THE LEFT SIDE OF THE EQUATION
C
  120 YTEM=FUNCT(DIFT,DEP,PHI)
      Y1=DEP-YTEM
      CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)
      SIDLEF=QPP**2/(32.2*A)+A*Y1
      D2=2.*CRITD-D5
      DT=3.*DIFT-D2
      D2=D2+DT/2.
C
C  LOOK FOR D2 LESS THAN OR EQUAL TO 3 DIAMETERS
C BY SOLVING FOR RIGHT SIDE OF THE EQUATION BY CONVERGENCE PROCESS
C
160   IF (DT/DENOM.LT.0.005) GO TO 230
      IF(D2.LT.DIFT) GO TO 130
C
C FULL FLOW PIPE
C
      A=DIFT**2*.7853982
      Y2=D2-0.5*DIFT
       GO TO 200
C
C PARTIAL FLOW PIPE
C
  130 DEP=D2-DIFT/2.
       IF (DEP.LT.0.0) GO TO 140
      PHI=ARSIN(2.*DEP/DIFT)
       GO TO 150
  140 PHI=-ARSIN(-2.*DEP/DIFT)
  150 YTRY=FUNCT(DIFT,DEP,PHI)
       Y2=DEP-YTRY
      CALL CIRCLE(D2,A,S,DIFT,QPP,MANN)
200    SIDRIT=QPP**2/(32.2*A)+A*Y2
      DENOM=DENOM*2.
C
C CHECK THAT THE LEFT SIDE EQUALS THE RIGHT SIDE OF THE EQUATION
C
      IF (SIDRIT-SIDLEF) 210,230,220
C
C INCREMENT D2 ACCORDING TO WHETHER THE TRIAL DEPTH (DT) IS GREATER OR L
C THE ACTUAL SOLUTION
C
210   D2=D2+DT/DENOM
      GO TO 160
220   D2=D2-DT/DENOM
      GO TO 160
230   D5=DSTORE
      RETURN
      END
```

```
      SUBROUTINE KTFACT(AVGH,BWHEL,TK)                                  00001
      DOUBLE PRECISION X100, BWHEL
      COMMON/F100/N100,CLREL,HEL,Q100,V100,WTL100,X100(100),Y100(100)   00003
      TK=1.0                                                            00004
      HT=WTL100-AVGH                                                    00005
      HH=BWHEL-AVGH                                                     00006
      IF(HH.LT.0.0001) HH=0.0001                                        00007**8
      HFAC=HT/HH                                                        00008
      IF(HFAC.LT.0.80) GO TO 1845                                       00009
      IF(HFAC.GT.0.85) GO TO 1841                                       00010
      TK=0.97+0.03*(0.85-HFAC)/0.05                                     00011
      GO TO 1845                                                        00012
 1841 IF(HFAC.GT.0.90) GO TO 1842                                       00013
      TK=0.90+0.07*(0.90-HFAC)/0.05                                     00014
      GO TO 1845                                                        00015
 1842 IF(HFAC.GT.0.95) GO TO 1843                                       00016
      TK=0.72+0.18*(0.95-HFAC)/0.05                                     00017
      GO TO 1845                                                        00018
 1843 IF(HFAC.GE.1.0) GO TO 1880                                        00019
      TK=0.0+0.72*(1.00-HFAC)/0.05                                      00020
      RETURN                                                            00021
 1880 TK=0.0                                                            00022
 1845 RETURN                                                            00023
      END                                                               00024
      SUBROUTINE MLTPLT(CRITD,SO2,IHIGH,IWIDE,*)                        00001**5
      DIMENSION BA(66),PI(66),IPROD(66),RA(66),RISEA(66),RPRA(66),      00002
     1 SO2A(66)                                                         00003
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH       00004*10
      INTEGER SHAPE,PROFIL,OPENGS                                       00005**5
      COMMON/ARCHP/A1,AK1,AK2,ALPHA,ARC,B,BETA,D1,D3,D5,H1,H2,H3,R1,R2, 00006
     1 R3,W,WPR                                                         00007
      COMMON ACRES,CA,FREQ,QPEAK,TC,       ISECN(50,50),ISTA(50),       00008
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00009**5
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00010
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00011
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00012**4
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00013**9
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00014**4
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00015**4
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00017**5
      DATA IPROD/4015,4332,4779,5124,5481,5980,6365,6762,7313,          00018
     17738,8400,8778,9243,9963,10624,11135,11919,12371,12922,13764,     00019
     214250,14744,15400,16261,17201,17745,18297,19402,20424,21018,21620,00020
     322420,23443,24079,24320,25350,26136,27336,28016,28842,30100,30814,00021
     432112,32850,34188,35100,35872,36806,38220,39026,17808,18468,19488,00022
     520060,20760,21838,22816,23562,4015,4779,5481,6270,7313,8400,      00023
     69243,10624/                                                       00024
      DATA BA/1.750,1.708,1.833,1.783,1.733,1.867,1.808,1.742,1.892,    00025
     11.825,1.983,1.908,1.825,2.000,2.175,2.092,2.283,2.192,2.100,2.292,00026
     22.200,2.100,2.000,2.200,2.408,2.300,2.192,2.408,2.633,2.517,2.400,00027
     32.292,2.508,2.392,3.342,3.517,3.433,3.617,3.533,3.450,3.633,3.542,00028
     43.733,3.642,3.833,3.742,3.650,3.550,3.750,3.650,3.217,3.150,3.300,00029
     53.242,3.167,3.325,3.492,3.417,1.750,1.792,1.833,1.875,1.917,1.958,00030
     6 2.000,2.042/                                                     00031
      DATA RISEA/4.583,4.758,4.908,5.092,5.267,5.417,5.600,5.783,5.925, 00032
     16.108,6.258,6.442,6.625,6.767,6.908,7.092,7.242,7.425,7.608,7.750,00033
     27.933,8.117,8.308,8.442,8.583,8.767,8.958,9.100,9.233,9.425,9.608,00034
```

```
     39.800,9.933,10.125,10.708,10.850,11.033,11.183,11.358,11.542,
     411.692,11.867,12.017,12.200,12.342,12.525,12.708,12.892,13.033,
     513.217,9.358,9.533,9.683,9.867,10.042,10.192,10.342,10.525,4.583,
     6 4.917,5.250,5.583,5.917,6.250,6.583,6.917/
      DATA SO2A/3.042,3.167,3.383,3.508,3.625,3.850,3.967,4.075,4.308,
     14.417,4.658,4.758,4.858,5.108,5.350,5.458,5.700,5.808,5.908,6.158,
     26.258,6.350,6.433,6.700,6.967,7.058,7.142,7.408,7.667,7.767,7.850,
     37.933,8.208,8.292,7.900,8.142,8.250,8.483,8.592,8.700,8.942,
     49.050,9.292,9.392,9.642,9.750,9.850,9.942,10.200,10.292,6.642,
     56.758,6.983,7.108,7.200,7.442,7.675,7.792,3.052,3.377,3.615,3.965,
     64.295,4.663,4.882,5.343/
      DATA RA/3.067,3.175,3.417,3.525,3.625,3.875,3.975,4.075,4.325,
     14.417,4.683,4.775,4.858,5.125,5.408,5.492,5.783,5.850,5.925,6.225,
     26.292,6.367,6.442,6.725,7.033,7.092,7.158,7.466,7.783,7.833,7.892,
     37.958,8.267,8.325,7.933,8.208,8.292,8.575,8.650,8.733,9.017,9.092,
     49.383,9.458,9.750,9.825,9.900,9.975,10.267,10.333,6.675,6.775,
     57.033,7.133,7.217,7.483,7.758,7.842,3.062,3.397,3.625,3.980,4.312,
     6 4.688,4.897,5.375/
      DATA RPRA/6.358,8.217,6.958,8.683,11.350,9.150,11.492,15.242,
     111.750,14.892,12.050,14.792,18.975,14.858,12.767,15.033,13.158,
     215.267,18.033,15.542,18.067,21.450,26.225,21.232,18.392,21.175,
     324.800,21.192,18.900,21.307,24.292,28.175,24.242,27.725,21.717,
     419.667,21.932,20.083,22.232,24.825,22.550,24.975,22.875,25.192,
     523.217,25.425,28.042,31.190,28.173,31.125,16.050,18.333,16.492,
     618.550,21.382,18.975,17.375,19.342,6.355,7.730,8.375,9.667,11.042,
     7 12.647,13.375,15.417/
      DATA PI/34*1.500,24*2.583,8*1.500/
C
C MLTPLT MATCHES ARCH PLATE PIPE TO STANDARDS AND CALCULATES CRITICAL SL
C AND CRITICAL DEPTH FOR SAME
C
      IHIWD=HIGH*WIDE
      KS=1
      KND=58
      IF (MAT.EQ.3) GO TO 100
      KS=59
      KND=66
100   DO 101 M=KS,KND
      K=M
       IF (IHIWD.EQ.IPROD(M)) GO TO 102
101   CONTINUE
CDEL  WRITE (SYSOUT,1000)
 1000 FORMAT (' CLB0104B--NOMINAL DIMENSIONS GIVEN DO NOT AGREE WITH',
     .' STANDARD DIMENSIONS.')
      RETURN1
      ENTRY PLWIDE(KK,SO2)
      SO2 = SO2A(KK)
      RETURN
      ENTRY CGMDES(KK,CRITD,SO2,IHIGH,IWIDE)
      K = KK
C
C COMPUTE DIMENSIONS FOR USE IN THIS AND OTHER ROUTINES
C
102   R2=RA(K)
      R1=RPRA(K)
      HIFT=RISEA(K)
      HIGH=HIFT*12.
```

```
      SO2=SO2A(K)                                                       00092
      WIFT=2.*SO2                                                       00093**9
      WIDE=WIFT*12.                                                     00094**9
      R3=PI(K)                                                          00095
      KC(34)=R3                                                         00096
      W=(SO2-R3)*2.                                                     00097
      DT=R2-HIFT+BA(K)                                                  00098**9
      THETA=ARSIN(W/(R1-R3)/2.)                                         00099
      BETA=1.5708-THETA                                                 00100
      D1=R3*COS(THETA)                                                  00101
      ALPHA=2.*ATAN(W/DT/2.)                                            00102
      D4=R3*SIN(1.5708-ALPHA/2.)                                        00103
      H1=R1*(1.-COS(THETA))                                             00104
      B=HIFT-R2                                                         00105**9
      D3=D1-(B-H1)+D4                                                   00106
      A1=W/2.+R3*SIN(THETA)                                             00107
      H2=D1                                                             00108
      H3=D4                                                             00109
      AK1=TAN(THETA)                                                    00110
      AK2=TAN(ALPHA/2.)                                                 00111
      QPP=QPEAK/BBLS                                                    00112
C                                                                       00113
C FIND CRITICAL DEPTH BY MATCHING THE RIGHT SIDE OF THE EQUATION TO THE 00114
C SIDE BY A CONVERGENCE METHOD                                          00115
C                                                                       00116
      SLEF=QPP**2/32.2                                                  00117
      D5=HIFT/2.-0.01                                                   00118**9
      DENOM=2.                                                          00119
  103 IF(HIFT/DENOM.LT.0.005) GO TO 200                                 00120**9
      CALL AREAH                                                         00121
      IF (D5.GE.(H1+H2+H3)) GO TO 104                                   00122
      IF (D5.GE.(H1+H2)) GO TO 105                                      00123
      IF (D5.GE.H1) GO TO 106                                           00124
      FACTER = R1 - D5                                                  00125**2
      FACTOR = R1 * R1 - FACTER * FACTER                                00126**2
      IF ( FACTOR .LE. 0.0 ) FACTOR = 0.001                             00127**2
      T = 2. * SQRT ( FACTOR )                                          00128**2
      GO TO 107                                                         00129
104   CONTINUE                                                          00130**2
      FACTER = D5 - B                                                   00131**2
      FACTOR = R2 * R2 - FACTER * FACTER                                00132**2
      IF ( FACTOR .LE. 0.0 ) FACTOR = 0.001                             00133**2
      T = 2. * SQRT ( FACTOR )                                          00134**2
      GO TO 107                                                         00135
105   CONTINUE                                                          00136**2
      FACTER = D5 - H1 - H2                                             00137**2
      FACTOR = R3 * R3 - FACTER * FACTER                                00138**2
      IF ( FACTOR .LE. 0.0 ) FACTOR = 0.001                             00139**3
C                  VALUES OF FACTOR SET TO 0.001 SET AT REQUEST OF      00140**3
C                  DWIGHT REAGAN CIRCA 20 JAN 76.  THESE VALUES         00141**3
C                  AVOID A SQUARE ROOT PROBLEM IN THE WATER DEPTH OF    00142**3
C                  THE ARCH PIPE HERE.                                  00143**3
      T = 2. * ( W / 2. + SQRT ( FACTOR ) )                             00144**2
      GO TO 107                                                         00145
106   CONTINUE                                                          00146**2
      FACTER = D1 - ( D3 - H1 )                                         00147**2
      FACTOR = R3 * R3 - FACTER * FACTER                                00148**2
```

```
      IF ( FACTOR .LE. 0.0 ) FACTOR = 0.001                            00149**2
      T = 2. * ( W / 2. + SQRT ( FACTOR ) )                            00150**2
107   SRGT=ARC**3/T                                                    00151
      DENOM=DENOM*2.                                                   00152
      IF (SLEF-SRGT) 108,200,109                                       00153
  108 D5=D5-HIFT/DENOM                                                 00154**9
      GO TO 103                                                        00155
  109 D5=D5+HIFT/DENOM                                                 00156**9
      GO TO 103                                                        00157
200   CRITD=D5                                                         00158
C                                                                      00159
C FIND CRITICAL SLOPE                                                  00160
C                                                                      00161
      CALL AREAH                                                        00162
      CALL WETPR                                                       00163
      R=ARC/WPR                                                        00164
      CRSLPE=QPP**2*MANN**2/(2.208*ARC**2*R**(4./3.))                  00165
      IHIGH=RISEA(K)*12.0                                              00166
      IF (PI(K).EQ.1.5) IHIGH=RISEA(K)*12.0+0.4                        00167
      IWIDE=IPROD(K)/IHIGH                                             00168
      RETURN                                                           00169
      END                                                              00170
      SUBROUTINE SPANS (HIFT,MAXHW1,QPEAK,KECF,BBLS,WIFT,JFLAG,WT)     00001**4
      REAL MAXHW1,KECF                                                 00002
C                                                                      00003
C SPANS CALCULATES BARRELS AND WIDTH NEEDED TO PASS GIVEN FLOW AT A GIVE00004
C HEIGHT USING THD STANDARDS.                                          00005
C                                                                      00006
      IF (JFLAG.NE.0) GO TO 16                                         00007
C                                                                      00008
C ESTABLISH A BEGINNING CULVERT WIDTH                                  00009
C                                                                      00010
      QODU=ALOG10((AMIN1(MAXHW1/HIFT,6.)+4.)/4.201)/.02592             00011**4
      QPFT=QODU*HIFT**1.5                                              00012**4
      WT=QPEAK/QPFT                                                    00013
      IF (WT.LT.1.0) WT=1.0                                            00014
      KW=WT                                                            00015
      WT=KW                                                            00016
      IF(HIFT.GE.9.0) WT=AMAX1(11.,WT)                                 00017**4
16    IF (WT.GT.10.0) GO TO 2                                          00018
      BBLS=1.                                                          00019
      GO TO 3                                                          00020
2     BBLS=0.                                                          00021
C                                                                      00022
C ESTABLISH A BEGINNING BARREL WIDTH                                   00023
C                                                                      00024
3     T=10.                                                            00025
  4   IF(T.GE.HIFT) GO TO 5                                            00026**4
C                                                                      00027
C INCREMENT THE CULVERT WIDTH IF NECESSARY                             00028
C                                                                      00029
14    WT=WT+1.                                                         00030
      IF (JFLAG.EQ.-1) WT=WT-2.                                        00031
      IF(WT.GE.HIFT) GO TO 3                                           00032**4
      KWB=1                                                            00033
      T=HIFT                                                           00034**4
      GO TO 15                                                         00035
```

```
C
C ESTABLISH THE MAXIMUM AMOUNT THAT THE WIDTH CAN EXCEED THE HEIGHT
C
5     IF (T.LT.5.) GO TO 6
      IF (T.LT.7.) GO TO 7
      IF (T.EQ.10.) GO TO 8
9     ADIF=4.
      GO TO 11
6     IF (T.EQ.4.) GO TO 10
      T=3.
      ADIF=1.
      GO TO 11
10    ADIF=2.
      GO TO 11
7     ADIF=3.
      GO TO 11
8     IF (BBLS.NE.1.) GO TO 9
      ADIF=5.
11    WB=WT/T
      KWB=WB
      DIF=WB-KWB
C
C CHECK IF CULVERT WIDTH CAN BE BROKEN DOWN INTO A WHOLE NUMBER OF BARRE
C
      IF (DIF.EQ.0.0) GO TO 12
C
C INCREMENT BARREL WIDTH AND TRY AGAIN
C
13    T=T-1.
      IF((T-HIFT).GT.ADIF) GO TO 13                                     **4
      IF (T.LT.3.0) GO TO 14
      GO TO 4
C
C CHECK THAT HIGH AND WIDE ARE A STANDARD SIZE
C
  12  IF((T-HIFT).GT.ADIF) GO TO 13                                     **4
      IF (KWB.EQ.1) GO TO 15
      IF (T.LT.5.0) GO TO 14
15    BBLS=KWB
      WIFT=T                                                            **4
      RETURN
      END
      SUBROUTINE WETPR
      COMMON/ARCHP/A1,AK1,AK2,ALPHA,ARC,B,BETA,D1,D3,D5,H1,H2,H3,R1,R2,
     1 R3,W,WPR
C
C WETPR COMPUTES WETTED PERIMETER FOR ARCH PIPE
C
C THE PIPE CROSS-SECTION HAS BEEN DIVIDED INTO 4 SECTIONS BY HEIGHT, AND
C FORMULA DERIVED TO CALCULATE EACH SEGMENTS PERIMETER.
C THE 4 WPR EQUATIONS ACCOMPLISH THIS
C
C
      HT1=H1
      HT2=H2
      HT3=H3
      IF (D5.GE.H1) GO TO 1
```

```
      H1=D5
1     WPR=2.*R1*ARSIN(SQRT(2.*R1*H1-H1**2)/R1)
      IF (D5.LE.H1) GO TO 4
      IF (D5.GE.(H1+H2)) GO TO 2
      H2=D5-H1
      IF ((D1-H2).LE.R3) GO TO 2
      H2=D1-R3
2     ALPHA1=ARSIN((D1-H2)/R3)
      PSI=BETA-ALPHA1
      WPR=WPR+2.*R3*PSI
      IF (D5.LE.(H1+H2)) GO TO 4
      IF (D5.GE.(H1+H2+H3)) GO TO 3
      H3=D5-H1-H2
      IF (H3.LE.R3) GO TO 3
      H3=R3
3     RHO=ARSIN(H3/R3)
      WPR=WPR+2.*R3*RHO
      IF (D5.LE.(H1+H2+H3)) GO TO 4
      DELTA=ALPHA/2.-ARCOS(AMIN1((D5-B)/R2,9.999999E-1))
      WPR=WPR+2.*R2*DELTA
4     H1=HT1
      H2=HT2
      H3=HT3
      RETURN
      END
C-----------------------------------------------------------------------
C-----CONVERT DARSIN TO DASIN
      FUNCTION DARSIN(ARG)
      REAL*8 ARG,DARSIN
      DARSIN=DASIN(ARG)
      RETURN
      END
C-----------------------------------------------------------------------
C-----CONVERT DARCOS TO DACOS
      FUNCTION DARCOS(ARG)
      REAL*8 ARG,DARCOS
      DARCOS=DACOS(ARG)
      RETURN
      END
C-----------------------------------------------------------------------
C-----CONVERT DCOTAN TO 1/DTAN
      FUNCTION DCOTAN(ARG)
      REAL*8 ARG,DCOTAN
      DCOTAN=1.0D0/DTAN(ARG)
      RETURN
      END
C-----------------------------------------------------------------------
C-----CONVERT ARSIN TO ASIN
      FUNCTION ARSIN(ARG)
      REAL ARG,ARSIN
      ARSIN=ASIN(ARG)
      RETURN
      END
C-----------------------------------------------------------------------
C-----CONVERT ARCOS TO ACOS
      FUNCTION ARCOS(ARG)
      REAL ARG,ARCOS
```

```
      ARCOS=ACOS(ARG)
      RETURN
      END
C-----------------------------------------------------------------------
C-----CONVERT COTAN TO 1/TAN
      FUNCTION COTAN(ARG)
      REAL ARG,COTAN
      COTAN=1.0D0/TAN(ARG)
      RETURN
      END
C-----------------------------------------------------------------------
      SUBROUTINE RC100(HH)                                              00001
      REAL LEN                                                          00002
      DOUBLE PRECISION  X100,HHH,HHEL,BWHEL                             00003*21
      COMMON ACRES,CA,FREQ,QPEAK,TC,ISECN(50,50),ISTA(50),              00004
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00005*19
      COMMON/F100/N100,CLREL,HEL,Q100,V100,WTL100,X100(100),Y100(100)   00006
      QPEAK=0.0                                                         00007
      QH=0.0                                                            00008
      HHH = HH                                                          00009*21
      HHEL = HEL                                                        00010*21
      BWHEL = HHEL + HHH                                                00011*21
      DO 1840 LS=2,N100                                                 00012
       H1=BWHEL-Y100(LS-1)                                              00013
       H2=BWHEL-Y100(LS)                                                00014
       IF(Y100(LS-1).GT.BWHEL) GO TO 1805                               00015
       IF(Y100(LS).GT.BWHEL) GO TO 1807                                 00016
       IF(Y100(LS-1).EQ.BWHEL.AND.Y100(LS).EQ.BWHEL) GO TO 1840         00017
      LEN=DABS(X100(LS)-X100(LS-1))                                     00018
      AVGH=(Y100(LS-1)+Y100(LS))*0.5                                    00019
      CALL KTFACT(AVGH,BWHEL,TK)                                        00020
      IF(H1.EQ.H2) GO TO 1809                                           00021
       QH=QH+TK* 3.0*LEN*(-2.0/5.0/(H1-H2))*(H2**2.5-H1**2.5)           00022
       GO TO 1840                                                       00023
 1805  IF(Y100(LS).GE.BWHEL) GO TO 1840                                 00024
      XDIF=X100(LS-1)-X100(LS)                                          00025
      LEN = DABS((BWHEL-Y100(LS))*XDIF/(Y100(LS-1)-Y100(LS)))           00026*21
      AVGH=(BWHEL+Y100(LS))*0.5                                         00027
      CALL KTFACT(AVGH,BWHEL,TK)                                        00028
       QH=QH+TK*(3.0*LEN*(-2.0/5.0/(-H2))*H2**2.5)                      00029
       GO TO 1840                                                       00030
 1807  IF(Y100(LS-1).EQ.BWHEL) GO TO 1840                               00031
      XDIF=X100(LS)-X100(LS-1)                                          00032
      LEN = DABS((BWHEL-Y100(LS-1))*XDIF/(Y100(LS-1)-Y100(LS)))         00033*21
      AVGH=(BWHEL+Y100(LS-1))*0.5                                       00034
      CALL KTFACT(AVGH,BWHEL,TK)                                        00035
       QH=QH+TK*(3.0*LEN*(-2.0/5.0/H1)*(-H1**2.5))                      00036
      GO TO 1840                                                        00037
 1809 QH=QH+TK*3.0*LEN*H1**1.5                                          00038
1840  CONTINUE                                                          00039
      QPEAK=Q100-QH                                                     00040
      RETURN                                                            00041
      END                                                               00042
      SUBROUTINE RC11 (INSTA1,OUTST1,INEL1,OUTEL1,*)                    00001
      DIMENSION ACO(6)                                                  00002
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH,      00003**8
     1 MAXHW1,INSTA1,INEL1                                              00004**8
```

```
      INTEGER SHAPE,PROFIL,OPENGS
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE
      COMMON/CCOM1/BRSUB(10),CLVTID,FLSEC,NAME,ORIGID,ROADID
      COMMON/ID/MOVEID,TOID,GSEC(50),CONYID,NAM,IS1,IS2,IDSEC(50)
      CHARACTER*3 CLVTID,BRSUB,NAME,ROADID
      CHARACTER*4 FLSEC,ORIGID,MOVEID,TOID,GSEC,CONYID,NAM,IS1,
     1 IS2,IDSEC
      COMMON/COSCOM/PRC(90),CONC,STL,FILLH,CMISC,COSFT,TOTCOS
C
C     THIS ROUTINE DESIGNS A STRAIGHT, CIRCULAR, NORMAL, SINGLE-OPENING
C     CULVERT.
C
      IF (DEPTH.GE.1.5) GO TO 100
CDEL  WRITE (SYSOUT,1006)
1006  FORMAT (  81H CLB0075--THE MINIMUM SIZE PIPE CONSIDERED FOR DESIGN
     $ IS 18 IN.  THIS EXCEEDS THE   /
     2      10X,          16HALLOWABLE DEPTH.   )
109   RETURN1
100   KFLAG=0
      ITYP=1
      NUMB=0
      SLOPE=(INEL-OUTEL)/ABS(OUTSTA-INSTA)
      MAXHW1=MAXHW-INEL
C
C DETERMINATION OF BEGINNING TRIAL SIZE
C
      IF (MAXHW1.GE.DEPTH) GO TO 108
      DIAM=IFIX(MAXHW1/(1.2-SLOPE*UPSS)*2.)*6.
      DIFT=DIAM/12.
      IF (DIAM.LE.DEPTH*12.) GO TO 101
  108 DIFT=IFIX(DEPTH*2.)/2.
      IF(DEPTH.LT.3.0) DIFT=IFIX(DEPTH*4.)/4.
      DIAM=DIFT*12.
101   IF (MAT.EQ.3) GO TO 110
C
C MINIMUM CGMP OR RCP SIZE=18 IN., MAXIMUM=120 IN.
C
      IF (DIAM.LT.18.0) DIAM=18.0
      IF (DIAM.GT.120.0) DIAM=120.0
      GO TO 102
C
C MINIMUM CIRC PLATE SIZE=5 FT., MAXIMUM=20 FT.
C
110   IF (DIAM.LT.60.0) DIAM=60.0
      IF (DIAM.GT.240.) DIAM=240.
  102 DIFT=DIAM/12.
C
C ARBITRARY DETERMINATION OF THE NUMBER OF BARRELS NEEDED
C
```

```
  103 MAXHW1=MAXHW-INEL+DIFT*UPSS*SLOPE
      FACT=ALOG10((MAXHW1/DIFT+0.8)/1.1506)/.08664
      QPBT=FACT*DIFT**2.5
      KT=QPEAK/QPBT
      IF (KT.LE.0) KT=1
      BBLS=KT
104   QPP=QPEAK/BBLS
      KC(60)=0
      MAXHW1=MAXHW-INEL+DIFT*UPSS*SLOPE
      GO TO (105,106,107), MAT
      GO TO 200
C
C N VALUE ASSIGNMENT
C
105   MANN=0.012
      GO TO 200
106   MANN=0.024
      ITYP=2
      IF(DIFT.GT.8.0) MANN=0.027
      GO TO 200
  107 MANN=10.**((ALOG10(DIFT+10.)-4.15076)/(-5.77698)-2.)
C
C DETERMINATION OF CRITICAL DEPTH AND CRITICAL SLOPE
C
  200 CALL CRITIC (QPP,DIFT,CRITD,CRSLPE,MANN)
      INSTA1=INSTA
      OUTST1= OUTSTA
      IF (INSTA1.LT.OUTST1) GO TO 201
      INSTA1=INSTA1-DIFT*UPSS
      OUTST1=OUTST1+DIFT*DNSS
      GO TO 202
  201 INSTA1=INSTA1+DIFT*UPSS
      OUTST1=OUTST1-DIFT*DNSS
202   LENGTH=ABS(INSTA1-OUTST1)
      TW=WATEL-(OUTEL+SLOPE*ABS(OUTSTA-OUTST1))
C
C TESTS TO DETERMINE PROPER HEADWATER CALCULATION
C
      IF (SLOPE.LT.CRSLPE) GO TO 203
      IF (TW.LE.SLOPE*LENGTH) GO TO 300
      IF(TW.LE.(SLOPE*LENGTH+DIFT)) GO TO 400
204   ADD=TW
      GO TO 500
203   IF (CRITD.GT.TW) GO TO 700
      IF(TW.LT.DIFT) GO TO 600
      GO TO 204
C
C KFLAG=4 IF TAILWATER MIGHT INFLUENCE HEADWATER ON STEEP SLOPE CULVERTS
C
400   KFLAG=4
C
C ENTRANCE CONTROL HEADWATER CALCULATION
C
300   IF (MAT.EQ.1) GO TO 307
      IF (KECF.EQ.0.2) KECF=0.5
      IF (KECF.EQ.0.7) GO TO 313
      IF (KECF.EQ.0.9) GO TO 314
```

```
C
C COEFFICIENTS FOR CGMP
C
      ACO(1)=0.167433
      ACO(2)=0.538595
      ACO(3)=-0.149374
      ACO(4)=0.0391543
      ACO(5)=-0.00343974
      ACO(6)=0.000115882
      GO TO 306
313   ACO(1)=0.107137
      ACO(2)=0.757789
      ACO(3)=-0.361462
      ACO(4)=0.123393
      ACO(5)=-0.0160642
      ACO(6)=0.000767390
      GO TO 306
314   ACO(1)=0.187321
      ACO(2)=0.567710
      ACO(3)=-0.156544
      ACO(4)=0.0447052
      ACO(5)=-0.00343602
      ACO(6)=0.000089661
      GO TO 306
307   IF (KECF.EQ.0.2) GO TO 308
      IF (KECF.EQ.0.25) GO TO 309
      IF (KECF.EQ.0.55) GO TO 310
C
C COEFFICIENTS FOR RCP
C
      ACO(1)=0.087483
      ACO(2)=0.706578
      ACO(3)=-0.253295
      ACO(4)=0.0667001
      ACO(5)=-0.00661651
      ACO(6)=0.000250619
      GO TO 306
310   ACO(1)=0.167287
      ACO(2)=0.558766
      ACO(3)=-0.159813
      ACO(4)=0.0420069
      ACO(5)=-0.00369252
      ACO(6)=0.000125169
      GO TO 306
309   ACO(1)=0.108786
      ACO(2)=0.662381
      ACO(3)=-0.233801
      ACO(4)=0.0579585
      ACO(5)=-0.00557890
      ACO(6)=0.000205052
      GO TO 306
308   ACO(1)=0.114099
      ACO(2)=0.653562
      ACO(3)=-0.233615
      ACO(4)=0.0597723
      ACO(5)=-0.00616338
      ACO(6)=0.000242832
```

```
  306 XENT=QPP/DIFT**2.5
      HWOD=ACO(1)
      P=1.
      DO 301 J=2,6
       P=P*XENT
       HWOD=HWOD+ACO(J)*P
301   CONTINUE
      BWH=HWOD*DIFT
      CALL BOXUD (SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
      IF(UDEP.NE.FLOAT(IFIX((100.*DIFT)*.93818)/100)) GO TO 311
      D5=UDEP
      GO TO 312
  311 CALL BWS2 (SHAPE,DIFT,QPP,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,D5,
     1 *109)
C
C CHECK FOR HYDRAULIC JUMP
C
      CALL JUMP (D5,DIFT,QPP,D2,CRITD,MANN)
      IF (D2.GT.TW) GO TO 312
      D5=AMIN1(TW,DIFT)
  312 CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)
      VO=QPP/A
      IF (KFLAG.NE.4) GO TO 800
      V3=VO
      HW3=BWH
      ADD=AMAX1(TW,CRITD)
C
C FULL FLOW - OUTLET CONTROL HEADWATER CALCULATION
C
  500 D5=DIFT
      CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)
      VO=QPP/A
      HE=(1.+KECF)*VO**2/64.4
      HF=LENGTH*S
      D5A=AMAX1(TW,CRITD)
      D5=AMIN1(DIFT,D5A)
      CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)
      VO=QPP/A
      BWH=ADD+HE+HF-SLOPE*LENGTH
      IF (KFLAG.NE.4) GO TO 800
      IF(TW.GE.DIFT) GO TO 502
      D5=AMAX1(TW,CRITD)
      GO TO 503
  502 D5=DIFT
  503 CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)
      V4=QPP/A
      HW4=BWH
C
C SELECT LARGEST HEADWATER WHERE TAILWATER MIGHT INFLUENCE HEADWATER ON
C STEEP SLOPE CULVERT
C
      IF (HW3.GT.HW4) GO TO 405
      BWH=HW4
C
C BWH BASED ON OUTLET CONDITIONS   KC(60)=1 BYPASSES RC12
C
      KC(60)=1
```

```
      VO=V4                                                             00234
      GO TO 800                                                         00235
405   BWH=HW3                                                           00236
      VO=V3                                                             00237
      GO TO 800                                                         00238
C                                                                       00239
C HEADWATER CALCULATION FOR TAILWATER GREATER THAN CRITICAL DEPTH BUT LE00240
C HIGH.  (SLOPE LESS THAN CRITICAL SLOPE)                               00241
C                                                                       00242
  600 CALL BOXUD (SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)             00243**7
      IF (TW-UDEP) 701,601,602                                          00244
  602 CALL BWM1 (SHAPE,TW,DIFT,WIFT,QPP,MANN,SLOPE,LENGTH,UDEP,WDEP)    00245**7
      D5=WDEP                                                           00246
      GO TO 603                                                         00247
601   D5=UDEP                                                           00248
      WDEP=UDEP                                                         00249
  603 CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)                                00250**7
      V=QPP/A                                                           00251
      BWH=(1.+KECF)*V**2/64.4+WDEP                                      00252
      D5=TW                                                             00253
      CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)                                00254**7
      VO=QPP/A                                                          00255
      GO TO 800                                                         00256
C                                                                       00257
C HEADWATER CALCULATION FOR OUTLET CONTROL BY CRITICAL DEPTH            00258
C  (NOT FULL FLOW)                                                      00259
C                                                                       00260
  700 CALL BOXUD (SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)             00261**7
  701 CALL BWM2 (TW,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLOPE,LENGTH,UDEP,   00262**7
     . WDEP,D5,DIST,HIFT)                                               00263**7
      IF (DIST.LT.LENGTH) GO TO 702                                     00264
      D5=WDEP                                                           00265
  703 CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)                                00266**7
      V=QPP/A                                                           00267
      HE=(1.+KECF)*V**2/64.4                                            00268
      BWH=WDEP+HE                                                       00269
      GO TO 706                                                         00270
705   D5=UDEP                                                           00271
      GO TO 703                                                         00272
  702 IF(WDEP.LT.0.93818*DIFT) GO TO 705                                00273**7
      D5=DIFT                                                           00274**7
      CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)                                00275**7
      V=QPP/A                                                           00276
      HF=(LENGTH-DIST)*(S-SLOPE)                                        00277
      HE=(1.+KECF)*V**2/64.4                                            00278
      BWH=DIFT+HE+HF                                                    00279**7
706   D5=AMAX1(TW,CRITD)                                                00280
      CALL CIRCLE (D5,A,S,DIFT,QPP,MANN)                                00281**7
      VO=QPP/A                                                          00282
800   IBBLS=BBLS                                                        00283
      IDIAM=DIFT*12.                                                    00284**7
      IWIDE=0                                                           00285
      ILEN=LENGTH                                                       00286
      IHIGH=0                                                           00287
      OUTEL1=OUTEL+SLOPE*(ABS(OUTSTA-OUTST1))                           00288
      INEL1=INEL-SLOPE*(ABS(INSTA-INSTA1))                              00289
      BWHEL=BWH+INEL1                                                   00290
```

```
C
C ESTIMATED COST CALCULATION
C
      IF (KC(64).NE.1) GO TO 810
      CALL IINDEX(J,DIFT,ITYP)
      CALL PIPCOS(J)
810   CONTINUE
      HWC=BWHEL
      VEC=VO
CDEL  WRITE (SYSOUT,4311) IBBLS,IDIAM,IWIDE,IHIGH,ILEN,MAXHW,BWHEL,BWH,
CDEL 1 VMAX,VO,TOTCOS
4311  FORMAT (2X,I3,I8,I7,I7,I7,F10.2,F9.2,F7.2,F8.2,F8.2,2X,F7.0)
C
C THE GENERAL AIM OF THIS ROUTINE IS TO BEST SATISFY ALLOWABLE HEADWATER
C AT THE SAME TIME, FIND A HEADWATER WHICH SUBMERGES THE CULVERT SOFFIT
C
      IF (BWH.LE.MAXHW1) GO TO 801
      NUMB=NUMB+1
      IF (NUMB.LE.200) GO TO 803
CDEL  WRITE (SYSOUT,1001)
1001  FORMAT (  71H CLB0076--CONDITIONS FOR THIS CULVERT CANNOT BE ECONO
     $MICALLY SATISFIED.  )
      GO TO 109
803   IF (KC(26).NE.1) GO TO 806
C
C RECALL STORED VALUES FOR PREVIOUS TRIAL SIZE
C
      INSTA1=STNKP
      OUTST1=STOKP
      INEL1=ELNKP
      OUTEL1=ELOKP
      DIFT=DKP
      BBLS=BKP
      LENGTH=ELKP
      BWH=BWKP
      VO=VKP
      KC(60)=KCKP
      IBBLS=BBLS
      IDIAM=DIFT*12.
      ILEN=LENGTH
CDEL  WRITE (SYSOUT,1000) IBBLS,IDIAM,ILEN
1000  FORMAT (/2X,'****  BARRELS=',I3,'  DIAMETER=',I4,'  LENGTH=',I4,
     1 '  IS THE ACCEPTED DESIGN  ****')
      GO TO 802
C
C RESIZE CULVERT AND TRY AGAIN
C
806   IF (KC(22).NE.1) GO TO 804
      BBLS=BBLS+1.
      KC(23)=1
      GO TO 104
  804 DIFT=DIFT+0.25
      IF(DIFT.GT.3.0) DIFT=DIFT+0.25
      IF(DIFT.GT.DEPTH) GO TO 805
      IF (MAT.EQ.3) GO TO 103
      IF(DIFT.LE.10.0) GO TO 103
805   BBLS=BBLS+1.
```

```
      IF(DIFT.GT.3.0) DIFT=DIFT-0.25                                   00345**7
      DIFT=DIFT-0.25                                                   00346**7
      KC(23)=1                                                         00347
      GO TO 104                                                        00348
  801 IF(BWH.LT.DIFT) GO TO 807                                        00349**7
      IF(DIFT.EQ.1.5) GO TO 802                                        00350**7
      KC(26)=1                                                         00351
C                                                                      00352
C STORE VALUES FOR CURRENT TRIAL SIZE IN CASE IT IS THE MOST EFFICIENT 00353
C                                                                      00354
      KCKP=KC(60)                                                      00355
      STNKP=INSTA1                                                     00356
      STOKP=OUTST1                                                     00357
      ELNKP=INEL1                                                      00358
      ELOKP=OUTEL1                                                     00359
      DKP=DIFT                                                         00360**7
      BKP=BBLS                                                         00361
      ELKP=LENGTH                                                      00362
      BWKP=BWH                                                         00363
      VKP=VO                                                           00364
C                                                                      00365
C RESIZE CULVERT FOR ANOTHER TRIAL                                     00366
C                                                                      00367
      IF(MAT.EQ.3.AND.DIFT.EQ.5.0) GO TO 802                           00368**7
      IF(DIFT.GT.3.0) DIFT=DIFT-0.25                                   00369**7
      DIFT=DIFT-0.25                                                   00370**7
      GO TO 104                                                        00371
807   KC(22)=1                                                         00372
      IF(DIFT.GT.3.0) DIFT=DIFT-0.25                                   00373**7
      DIFT=DIFT-0.25                                                   00374**7
      IF (MAT.EQ.3) GO TO 808                                          00375
      IF(DIFT.GE.1.5) GO TO 103                                        00376**7
      DIFT=1.5                                                         00377**7
      GO TO 809                                                        00378
  808 IF(DIFT.GE.5.0) GO TO 103                                        00379**7
      DIFT=5.0                                                         00380**7
809   IF (KC(23).EQ.1) GO TO 802                                       00381
      BBLS=BBLS-1.                                                     00382
      IF (BBLS.NE.0.0) GO TO 104                                       00383
      BBLS=1.                                                          00384
  802 DIAM=DIFT*12.0                                                   00385**7
      KC(26)=0                                                         00386
      KC(22)=0                                                         00387
      KC(23)=0                                                         00388
      KC(37)=1                                                         00389
      RETURN                                                           00390
      END                                                              00391
      SUBROUTINE RC12 (INSTA1,OUTST1,INEL1,OUTEL1,*)                   00001**8
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH,     00002**8
     1 INSTA1,INEL1                                                    00003**8
      INTEGER SHAPE,PROFIL,OPENGS                                      00004**4
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),       00005
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                     00006**4
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),             00007
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV    00008
      COMMON/COSCOM/PRC(90),CONC,STL,FILLH,CMISC,COSFT,TOTCOS          00009
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,     00010**3
```

```
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00011**7
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00012**3
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00013**3
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00015**4
      DIMENSION QT(6),ACO(6)                                            00016
C                                                                       00017
C     THIS ROUTINE DESIGNS A STRAIGHT, CIRCULAR, FLARED,                00018
C     SINGLE-OPENING CULVERT                                            00019
C                                                                       00020
      IF (DEPTH.GE.1.5) GO TO 106                                       00021
CDEL  WRITE (SYSOUT,1006)                                               00022
1006  FORMAT (  81H CLB0075--THE MINIMUM SIZE PIPE CONSIDERED FOR DESIGN00023**2
     $ IS 18 IN.  THIS EXCEEDS THE     /                                00024**2
     2       10X,          16HALLOWABLE DEPTH.  )                       00025**2
      GO TO 406                                                         00026
106   KC(36)=0                                                          00027
      SLOPE=(INEL-OUTEL)/ABS(INSTA-OUTSTA)                              00028
      IF(KC(37).EQ.1)GO TO 100                                          00029
C                                                                       00030
C ASSIGN N VALUE IF NECESSARY                                           00031
C                                                                       00032
      IF (MANN.EQ.1.0) MANN=0.012                                       00033
      IF (MANN.EQ.2.0) MANN=0.024                                       00034
      IFLAG=0                                                           00035
      GO TO 105                                                         00036
100   IFLAG=1                                                           00037
      KC(38)=1                                                          00038
105   BBLS=1.                                                           00039
      KC(37)=0                                                          00040
      QTEM=QPEAK                                                        00041
C                                                                       00042
C ONLY RCP AND CGMP PROCESSED IN THIS ROUTINE                           00043
C                                                                       00044
      IF (MAT.EQ.1.OR.MAT.EQ.2) GO TO 101                               00045
CDEL  WRITE (SYSOUT,1004)                                               00046
1004  FORMAT (  72H CLB0078--CURVES ARE ONLY VALID FOR STANDARD REINFORC00047**2
     $ED CONCRETE PIPE OR    /                                          00048**2
     2       10X,          22HCORRUGATED METAL PIPE.  )                 00049**2
      GO TO 406                                                         00050
101   XD=10000000.                                                      00051
      K=5                                                               00052
C                                                                       00053
C TRIALS MADE FOR Q/D**(5/2) OF FROM 0.5 TO 8.5.  (ORIGINAL RANGE       00054
C  OF CURVES FROM BPR)                                                  00055
C                                                                       00056
102   QOD=K/10.                                                         00057
C                                                                       00058
C MINIMUM DIAMETER OF 18 INCHES                                         00059
C                                                                       00060
      D=(QTEM/QOD)**0.4                                                 00061
      IF (D.LT.1.5) D=1.5                                               00062
      QT(1)=QOD                                                         00063
      DO 103 L=2,6                                                      00064
103    QT(L)=QT(L-1)*QOD                                                00065
      IF (QOD.GE.5.0) GO TO 104                                         00066
C                                                                       00067
C HW/D ADJUSTMENT TO SLOPE                                              00068
```

```
C
      F=0.0986333+0.145845*QT(1)-0.0130606*QT(2)
      GO TO 200
104   F=0.5
200   L=0
      IF (MANN.NE.0.012) GO TO 205
      ITYP=1
C
C ONE CURVE FOR RCP
C
      BIG=0.216805+0.396390*QT(1)-0.0533907*QT(2)+0.00797812*QT(3)
     1-0.000281416*QT(4)
      GO TO 206
205   BIG1=0.0
      BIG2=0.
      BIG3=0.0
      BIG4=0.0
      ITYP=2
C
C FOUR CURVES FOR CGMP DEPENDING ON DIAMETER
C
      IF (D.LT.4.0) BIG1=0.342975+0.0277890*QT(1)+0.260673*QT(2)
     1 -0.108629*QT(3)+0.0214553*QT(4)-0.00197451*QT(5)+0.0000697351
     2 *QT(6)
      IF (D.GT.2.0.AND.D.LT.6.0) BIG2=0.351342+0.00107965*QT(1)
     1+0.287643*QT(2)-0.121769*QT(3)+0.0244625*QT(4)-0.00229750*QT(5)
     2 +0.0000828621*QT(6)
      IF (D.GT.4.0.AND.D.LT.8.0) BIG3=0.349196+0.00936189*QT(1)
     1 +0.276799*QT(2)-0.116937*QT(3)+0.0234314*QT(4)-0.00219361*QT(5)
     2 +0.0000788166*QT(6)
      IF (D.GT.6.0) BIG4=0.349380+0.0102961*QT(1)+0.271994*QT(2)
     1 -0.114066*QT(3)+0.0226731*QT(4)-0.00210414*QT(5)+0.0000749226
     2 *QT(6)
C
C INTERPOLATION FOR CGMP
C
      BIG=(4.-AMAX1(2.,D))/2.*BIG1+(1.-ABS(4.-D)/2.)*BIG2+(1.-ABS(6.-D)
     1 /2.)*BIG3+(AMIN1(8.,D)-6.)/2.*BIG4
      IF (L.NE.1) GO TO 206
      HWPR=BIG
      GO TO 305
206   HTRY=D*(BIG-F*SLOPE)-SLOPE*1.5*D
      HWA=MAXHW-INEL+SLOPE*D*UPSS
      YD=ABS(HTRY-HWA)
      IF (YD.GT.XD) GO TO 201
      XD=YD
C
C DIAMETER CARRIED AS AN EXACT NUMBER
C
      DIFT=D
      DIAM=DIFT*12.
201   IF (K.EQ.85) GO TO 202
      K=K+1
      GO TO 102
C
C CHANGE DIAMETER UP TO NEXT NOMINAL SIZE
C
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```
  202 IF(DIFT.GT.3.0) GO TO 203
      JD=DIFT*4.+0.99
      DIFT=JD*25./100.
      DIAM=DIFT*12.
      GO TO 204
  203 JD=DIFT*2.+0.99
      DIFT=JD*50./100.
      DIAM=DIFT*12.
  204 IF(DIFT.LE.DEPTH.AND.DIFT.LE.10.0) GO TO 300
      BBLS=BBLS+1.0
      QTEM=QPEAK/BBLS
      GO TO 101
  300 QODN=QTEM/DIFT**2.5
      QT(1)=QODN
      DO 301 LA=2,6
       QT(LA)=QT(LA-1)*QODN
301   CONTINUE
C
C BEGIN CALCULATION OF HEADWATER FOR NORMAL DIAMETER
C
      IF (QODN.GE.5.0) GO TO 302
      F=0.0986333+0.145845*QT(1)-0.0130606*QT(2)
      GO TO 304
302   F=0.5
304   L=1
      D=DIFT
      IF (MANN.NE.0.012) GO TO 205
      HWPR=0.216805+0.396390*QT(1)-0.0533907*QT(2)+0.00797812
     1 *QT(3)-0.000281416*QT(4)
  305 HW=DIFT*(HWPR-F*SLOPE)-SLOPE*1.5*DIFT
      HWA=MAXHW-INEL+SLOPE*DIFT*UPSS
C
C COMPARE CALCULATED HEADWATER TO MAXIMUM HEADWATER
C
      IF (HW.LE.HWA) GO TO 400
      IF(DIFT.GE.3.0) DIFT=DIFT+.25
      DIFT=DIFT+0.25
      DIAM=DIFT*12.
  303 IF(DIFT.LE.DEPTH.AND.DIFT.LE.10.0) GO TO 300
      BBLS=BBLS+1.0
      QTEM=QPEAK/BBLS
      GO TO 101
  400 CALL CRITIC(QTEM,DIFT,CRITD,CRSLPE,MANN)
C
C CHECK SLOPE AGAINST CRITICAL SLOPE
C
      IF (SLOPE.LT.CRSLPE) GO TO 405
      LENGTH=ABS(OUTSTA-INSTA)-DIFT*(UPSS+DNSS)
      TW=WATEL-OUTEL-SLOPE*DNSS*DIFT
      IF(TW.LE.SLOPE*LENGTH+DIFT) GO TO 408
C
C JROUTE=1 IF TAILWATER NOT AN INFLUENCE ON HEADWATER
C JROUTE=2 IF OUTLET CONTROL CONSIDERED BUT LESS SIGNIFICANT THAN FLARED
C         INLET CONTROL
C JROUTE=3 IF OUTLET CONTROL CONSIDERED AND FOUND MORE SIGNIFICANT THAN
C         INLET CONTROL
C JROUTE=4 IF CULVERT SLOPE IS LESS THAN CRITICAL SLOPE
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C JROUTE=5 IF HEADWATER FOR ORDINARY ENTRANCE HAS BEEN CALCULATED AND FO00183
C          TO BE MORE SIGNIFICANT THAN HEADWATER FROM FLARED INLET.     00184
C          (PROBABLE DUMMY ROUTE)                                       00185
C                                                                       00186
      JROUTE=3                                                          00187
      GO TO 402                                                         00188
408   IF (TW.LE.SLOPE*LENGTH) GO TO 407                                 00189
      IF (MANN.EQ.0.012) GO TO 409                                      00190
      ACO(1)=0.167433                                                   00191
      ACO(2)=0.538595                                                   00192
      ACO(3)=-0.149374                                                  00193
      ACO(4)=0.0391543                                                  00194
      ACO(5)=-0.00343974                                                00195
      ACO(6)=0.000115882                                                00196
      GO TO 410                                                         00197
409   ACO(1)=0.114099                                                   00198
      ACO(2)=0.653562                                                   00199
      ACO(3)=-0.233615                                                  00200
      ACO(4)=0.0597723                                                  00201
      ACO(5)=-0.00616338                                                00202
      ACO(6)=0.000242832                                                00203
  410 XENT=QTEM/DIFT**2.5                                               00204**7
      HWOD=ACO(1)                                                       00205
      P=1.                                                              00206
      DO 411 J=2,6                                                      00207
      P=P*XENT                                                          00208
411   HWOD=HWOD+ACO(J)*P                                                00209
      HW3=HWOD*DIFT                                                     00210**7
      JROUTE=5                                                          00211
  402 HW4=QTEM**2/100.*(2.5204*(1.+KECF)/DIFT**4+466.153*MANN**2*LENGTH/00212**7
     . DIFT**(16./3.))+AMAX1(TW,CRITD)-SLOPE*LENGTH                     00213**7
      IF (JROUTE.EQ.3) GO TO 404                                        00214
      IF (JROUTE.EQ.5) GO TO 412                                        00215
      IF (HW.GT.HW4) GO TO 403                                          00216
413   IF (HW4.LE.HWA) GO TO 404                                         00217
  414 IF(DIFT.GE.3.0)DIFT=DIFT+.25                                      00218**7
      DIFT=DIFT+0.25                                                    00219**7
      DIAM=DIFT*12.                                                     00220**7
      GO TO 303                                                         00221
407   JROUTE=1                                                          00222
      BWH=HW                                                            00223
      KECF=1.                                                           00224
      GO TO 500                                                         00225
405   IF (IFLAG.NE.0) GO TO 401                                         00226
CDEL  WRITE (SYSOUT,1005)                                               00227
1005  FORMAT (  71H CLB0079--FLARED INLET DESIGN NOT PRACTICAL BECAUSE S00228**2
     $LOPE OF CULVERT IS     /                                          00229**2
     2          10X,      33HSUBCRITICAL.  PROBLEM TERMINATED. )        00230**2
      GO TO 406                                                         00231
401   CONTINUE
CDEL  WRITE (SYSOUT,1000)                                               00232
1000  FORMAT (  77H CLB0080--ORIGINAL CONVENTIONAL (NON-FLARED) DESIGN I00233**2
     $S ACCEPTABLE.  NO FLARED    /                                     00234**2
     2        10X,        26HINLET DESIGN IS PRACTICAL.  )              00235**2
406   JROUTE=4                                                          00236
      KC(36)=1                                                          00237
      GO TO 604                                                         00238
```

```
403   JROUTE=2                                                          00239
      BWH=HW                                                            00240
      KECF=1.                                                           00241
      GO TO 500                                                         00242
404   BWH=HW4                                                           00243
      KECF=0.2                                                          00244
      JROUTE=3                                                          00245
      GO TO 500                                                         00246
412   IF (HW.GT.HW4) GO TO 403                                          00247
      IF (HW3.LE.HW4) GO TO 413                                         00248
      IF (HW3.GT.HWA) GO TO 414                                         00249
      BWH=HW3                                                           00250
      KECF=0.2                                                          00251
500   GO TO (501,502,503,604), JROUTE                                   00252
CDEL  WRITE (SYSOUT,1007)                                               00253
1007  FORMAT (  74H CLB0081--FLARED INLET HAS NO EFFECT - HEADWATER BASE00254**2
     $D ON ENTRANCE CONTROL       /                                     00255**2
     2         10X,        14HWITH KE = 0.2.   )                        00256**2
      GO TO 506                                                         00257
501   CONTINUE
CDEL  WRITE (SYSOUT,1001)                                               00258
1001  FORMAT (  68H CLB0082--OUTLET CONDITIONS NOT CONSIDERED BECAUSE TW00259**2
     $ INSIGNIFICANT.  )                                                00260**2
      GO TO 506                                                         00261
502   CONTINUE
CDEL  WRITE (SYSOUT,1002)                                               00262
1002  FORMAT (  64H CLB0083--OUTLET CONDITIONS CONSIDERED BUT FOUND NOT 00263**2
     $TO CONTROL.  )                                                    00264**2
C                                                                       00265
C OUTLET VELOCITY CALCULATION WITH HYDRAULIC JUMP CONSIDERATION         00266
C                                                                       00267
  506 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QTEM,SLOPE,UDEP)             00268**7
      CALL BWS2(SHAPE,DIFT,QTEM,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,D5,   00269**8
     1 *605)                                                            00270**8
      CALL JUMP(D5,DIFT,QTEM,D2,CRITD,MANN)                             00271**7
      IF (D2.GT.TW) GO TO 507                                           00272
      D5=AMIN1(TW,DIFT)                                                 00273**7
  507 CALL CIRCLE(D5,A,S,DIFT,QTEM,MANN)                                00274**7
      VO=QTEM/A                                                         00275
      GO TO 600                                                         00276
503   CONTINUE
CDEL  WRITE (SYSOUT,1003)                                               00277
1003  FORMAT (  65H CLB0084--OUTLET CONDITIONS CONTROL - FLARED INLET HA00278**2
     $S NO EFFECT. )                                                    00279**2
      D5=AMIN1(TW,DIFT)                                                 00280**7
      CALL CIRCLE(D5,A,S,DIFT,QTEM,MANN)                                00281**7
      VO=QTEM/A                                                         00282
600   IF (INSTA.LT.OUTSTA) GO TO 601                                    00283
      INSTA1=INSTA-DIFT*UPSS                                            00284**7
      OUTST1=OUTSTA+DIFT*DNSS                                           00285**7
      GO TO 602                                                         00286
  601 INSTA1=INSTA+DIFT*UPSS                                            00287**7
      OUTST1=OUTSTA-DIFT*DNSS                                           00288**7
602   INEL1=INEL-SLOPE*ABS(INSTA-INSTA1)                                00289
      OUTEL1=OUTEL+SLOPE*ABS(OUTSTA-OUTST1)                             00290
      BWHEL=BWH+INEL1                                                   00291
      IF (KC(64).NE.1) GO TO 603                                        00292
```

```
C                                                                       00293
C COST CALCULATION                                                      00294
C                                                                       00295
      IDUM = 3                                                          00296**7
      CALL IINDEX(J,DIFT,IDUM)                                          00297**7
      KC(63)=J                                                          00298
      CALL IINDEX(J,DIFT,ITYP)                                          00299**7
      CALL PIPCOS(J)                                                    00300
  603 DIAM=DIFT*12.0                                                    00301**7
      IBBLS=BBLS                                                        00302
      IDIAM=DIAM                                                        00303
      IWIDE=0                                                           00304
      ILEN=LENGTH                                                       00305
      IHIGH=0                                                           00306
      HWC=BWHEL
      VEC=VO
CDEL  WRITE (SYSOUT,4311) IBBLS,IDIAM,IWIDE,IHIGH,ILEN,MAXHW,BWHEL,BWH, 00307
CDEL 1 VMAX,VO,TOTCOS                                                   00308
4311  FORMAT (2X,I3,I8,I7,I7,I7,F10.2,F9.2,F7.2,F8.2,F8.2,2X,F7.0)      00309
604   RETURN                                                            00310
  605 RETURN 1                                                          00311**8
      END                                                               00312
      SUBROUTINE RC14 (INSTA1,OUTST1,INEL1,OUTEL1)                      00001**9
      DIMENSION ACO(6),RISE(66),STAR(2)                                 00002
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,             00003**9
     1  LENGTH,MAXHW1,INSTA1,INEL1                                      00004
      INTEGER SHAPE,PROFIL,OPENGS                                       00005**4
      COMMON/ARCHP/A1,AK1,AK2,ALPHA,ARC,B,BETA,D1,D3,D5,H1,H2,H3,R1,R2, 00006
     1 R3,W,WPR                                                         00007
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),        00008
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00009**4
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00010
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00011
      COMMON/COSCOM/PRC(90),CONC,STL,FILLH,CMISC,COSFT,TOTCOS           00012
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00013**3
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00014**8
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00015**3
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00016**3
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00018**4
      CHARACTER*2 BLANK,STAR,FLAG                                       00019**4
      DATA RISE/0.938,1.125,1.500,1.875,2.250,2.625,3.000,3.375,3.750,  00020
     1 4.500,5.250,5.583,5.917,6.250,6.583,6.917,4.583,4.758,4.908,     00021
     2 5.092,5.267,5.417,5.600,5.783,5.925,6.108,6.258,6.442,6.625,     00022
     36.767,6.908,7.092,7.242,7.425,7.608,7.750,7.933,8.117,8.308,      00023
     48.442,8.583,8.767,8.958,9.100,9.233,9.425,9.608,9.800,9.933,      00024
     510.125,10.708,10.850,11.033,11.183,11.358,11.542,11.692,11.867,   00025
     612.017,12.200,12.342,12.525,12.708,12.892,13.033,13.217/,BLANK,   00026
     7 STAR/'  ','* ','**'/                                             00027
      SLOP(A,X,Y,D)=A**2*X**2/(2.208*Y**2*D**(4./3.))                   00028
C                                                                       00029
C THIS ROUTINE DESIGNS AN ARCH CULVERT WITH NORMAL OPENING AND STRAIGHT 00030
C                                                                       00031
C KC(22) IS AN INTERNAL FLAG TO SHOW THAT PIPE SIZE DECREASED BECAUSE BW00032
C LESS THAN MAXHW1, BUT BWH ALSO LESS THAN HIGH AND IS NOT SATISFACTORY 00033
C                                                                       00034
C KC(23) IS AN INTERNAL FLAG TO SHOW THAT BWH EXCEEDED MAXHW1 AND BBLS W00035
C INCREASED                                                             00036
```

```
C
C KC(24)=4 IS AN INTERNAL FLAG WHICH INDICATES THAT BWH MAY BE BASED ON
C CONTROL OR OUTLET CONTROL-WHICHEVER IS HIGHER
C
C KC(26) IS AN INTERNAL FLAG TO SHOW THAT A SATISFACTORY SIZE HAS BEEN U
C
C KC(34) IS A FLAG FROM CGMDES TO INDICATE SIZE OF RADIUS
C
100   CONTINUE
      NS=1
      NR=11
C
C N VALUE ASSIGNMENT
C
      GO TO (101,102,103), MAT
      GO TO 104
101   MANN=0.012
      ITYP=4
      GO TO 104
102   MANN=0.024
      ITYP=5
      NR=16
      GO TO 104
103   NS=17
      NR=66
104   SLOPE=(INEL-OUTEL)/ABS(INSTA-OUTSTA)
      TW=WATEL-OUTEL
      MAXHW1=MAXHW-INEL
C
C DETERMINATION OF BEGINNING TRIAL SIZE
C
      RISTRY=DEPTH
      IF (MAXHW1.LT.DEPTH) RISTRY=MAXHW1/1.2
      XA=10000000.
      DO 107 K=NS,NR
      YA=ABS(RISTRY-RISE(K))
      IF (YA.GT.XA) GO TO 108
      XA=YA
      NUSE=K
107   CONTINUE
108   IF (RISE(NUSE).LE.DEPTH) GO TO 109
      IF (NUSE.EQ.NS) GO TO 109
      NUSE=NUSE-1
      GO TO 108
109   IF (MAXHW1.GT.RISE(NUSE)) GO TO 110
      IF (NUSE.EQ.NS) GO TO 110
      NUSE=NUSE-1
      GO TO 109
  110 HIFT=RISE(NUSE)
      HIGH=HIFT*12.
      IF (INSTA.LT.OUTSTA) GO TO 111
      INSTA1=INSTA-HIFT*UPSS
      OUTST1=OUTSTA+HIFT*DNSS
      GO TO 112
  111 INSTA1=INSTA+HIFT*UPSS
      OUTST1=OUTSTA-HIFT*DNSS
  112 INEL1=INEL-HIFT*UPSS*SLOPE
```

```
      OUTEL1=OUTEL+HIFT*DNSS*SLOPE
      LENGTH=ABS(INSTA1-OUTST1)
      MAXHW1=MAXHW-INEL+HIFT*UPSS*SLOPE
C
C DETERMINE TRIAL WIDTH
C
      WIFT=1.62261*HIFT
      WIDE=WIFT*12.
      IF (MAT.NE.3) GO TO 113
      K=NUSE-16
      CALL PLWIDE (K,SO2)
      WIFT=2.*SO2
      WIDE=WIFT*12.
113   IF (KC(26).EQ.1) GO TO 203
C
C  DETERMINATION OF NUMBER OF BARRELS PER RISE(NUSE)
C
      QOARCH=((MAXHW1/HIFT-0.5)/0.11022)**0.588
      IBBLS=QPEAK/(QOARCH*WIFT*HIFT**1.5)
      BBLS=IBBLS
      IF (BBLS.LT.1.0) BBLS=1.0
203   QPP=QPEAK/BBLS
      IF (NUSE.LT.11.OR.MAT.EQ.1) GO TO 204
C
C IF PLATE OR CGM, DETERMINE WHICH AND SET PROPER N VALUE
C
      IF (MAT.NE.3) GO TO 205
      MANN=0.0371*((HIFT+WIFT)/2.)**(-0.0772)
      K=NUSE-16
      GO TO 206
205   K=NUSE+50
      MANN=0.027
C
C OBTAIN GEOMETRIC AND HYDRAULIC CHARACTERISTICS FOR LARGE SIZES FROM ML
C
  206 CALL CGMDES(K,CRITD,RDUM,IHIGH,IWIDE)
      GO TO 300
C
C OBTAIN GEOMETRIC AND HYDRAULIC CHARACTERISTICS FOR SMALL SIZES
C
204   IF (MAT.EQ.2) MANN=0.024
      A1=0.63333*HIFT
      B=0.16553*HIFT
      R1=2.33333*HIFT
      R2=0.83333*HIFT
      R3=0.24667*HIFT
      W=WIFT-2*R3
      D1=0.9624586*R3
      H1=0.03754141*R1
      H2=D1
      ALPHA=2.58842
      H3=0.2714286*R3
      D2=H3
      AK1=0.281898
      F2=D1
      AK2=F2/D2
      D3=D1+D2+H1-B
```

```
      BETA=1.29592                                                      00151
      FAC=QPP/(WIFT*HIFT**1.5)                                          00152**8
      IF (FAC.GT.10.5) GO TO 904                                        00153
C                                                                       00154
C DETERMINATION OF CRITICAL DEPTH AND CRITICAL SLOPE                    00155
C                                                                       00156
      CRITD=((((((-0.0000058507)*FAC+0.00019451)*FAC-0.0024461)*FAC     00157
     1 +0.015275)*FAC-0.065615)*FAC+0.30225)*FAC+0.11709)*HIFT          00158**8
      D5=CRITD                                                          00159
      CALL AREAH                                                        00160
      CALL WETPR                                                        00161
      R=ARC/WPR                                                         00162
      CRSLPE=SLOP(QPP,MANN,ARC,R)                                       00163
C                                                                       00164
C TESTS TO DETERMINE PROPER HEADWATER CALCULATION METHOD                00165
C                                                                       00166
300   IF (SLOPE.GT.CRSLPE) GO TO 301                                    00167
      IF (CRITD.GT.TW) GO TO 800                                        00168
      IF(TW.LE.HIFT) GO TO 700                                          00169**8
302   ADD=TW                                                            00170
      GO TO 600                                                         00171
301   IF (TW.LE.SLOPE*LENGTH) GO TO 400                                 00172
      IF(TW.GT.SLOPE*LENGTH+HIFT) GO TO 302                             00173**8
C                                                                       00174
C KC(24)=4 IF TAILWATER MIGHT INFLUENCE HEADWATER ON STEEP SLOPE CULVERT00175
C                                                                       00176
      KC(24)=4                                                          00177
C                                                                       00178
C ENTRANCE CONTROL HEADWATER CALCULATION                                00179
C                                                                       00180
400   CONTINUE
CDEL  IF (MANN.EQ.0.012) WRITE (SYSOUT,1000)                            00181
1000  FORMAT (' INLET CURVES BASED ON CGM MODELS. COMPUTATIONS CONTINUE'00182
     1)                                                                 00183
      IF (KECF.EQ.0.5) GO TO 401                                        00184
      IF (KECF.EQ.0.7) GO TO 402                                        00185
C                                                                       00186
C COEFFICIENTS FOR ENTRANCE CONTROL HEADWATER DETERMINATION POLYNOMIAL  00187
C                                                                       00188
      ACO(1)=0.089053                                                   00189
      ACO(2)=0.71254                                                    00190
      ACO(3)=-0.27092                                                   00191
      ACO(4)=0.079250                                                   00192
      ACO(5)=-0.0079805                                                 00193
      ACO(6)=0.00029321                                                 00194
      GO TO 404                                                         00195
402   ACO(1)=0.083301                                                   00196
      ACO(2)=0.79514                                                    00197
      ACO(3)=-0.43408                                                   00198
      ACO(4)=0.16377                                                    00199
      ACO(5)=-0.024914                                                  00200
      ACO(6)=0.0014107                                                  00201
      GO TO 404                                                         00202
401   ACO(1)=0.11128                                                    00203
      ACO(2)=0.61058                                                    00204
      ACO(3)=-0.19494                                                   00205
      ACO(4)=0.051289                                                   00206
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      ACO(5)=-0.0048054                                                 00207
      ACO(6)=0.00016855                                                 00208
  404 F=QPP/(WIFT*HIFT**1.5)                                            00209**8
      P=1.                                                              00210
      HOD=ACO(1)                                                        00211
      DO 405 J=2,6                                                      00212
       P=P*F                                                            00213
405   HOD=HOD+P*ACO(J)                                                  00214
      BWH=HIFT*HOD                                                      00215**8
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)              00216**8
      CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,D5,    00217**9
     1 *911)                                                            00218**9
      CALL AREAH                                                         00219
      VO=QPP/ARC                                                        00220
      IF (KC(24).NE.4) GO TO 900                                        00221
      D5=AMIN1(TW,HIFT)                                                 00222**8
      CALL AREAH                                                         00223
      V3=QPP/ARC                                                        00224
      HW3=BWH                                                           00225
      IF(TW.GE.HIFT) GO TO 501                                          00226**8
      P1=(CRITD+HIFT)/2.                                                00227**8
      GO TO 502                                                         00228
501   P1=TW                                                             00229
502   KC(24)=4                                                          00230
      ADD=P1                                                            00231
C                                                                       00232
C FULL FLOW - OUTLET CONTROL HEADWATER CALCULATION                      00233
C                                                                       00234
  600 D5=HIFT                                                           00235**8
      CALL AREAH                                                         00236
      VO=QPP/ARC                                                        00237
      CALL WETPR                                                        00238
      R=ARC/WPR                                                         00239
      SF=SLOP(QPP,MANN,ARC,R)                                           00240
      HE=(1.+KECF)*VO**2/64.4                                           00241
      HF=SF*LENGTH                                                      00242
      BWH=ADD+HE+HF-SLOPE*LENGTH                                        00243
      IF (KC(24).NE.4) GO TO 900                                        00244
      D5=AMAX1(TW,HIFT)                                                 00245**8
      CALL AREAH                                                         00246
      V4=QPP/ARC                                                        00247
      HW4=BWH                                                           00248
C                                                                       00249
C SELECT LARGEST HEADWATER WHERE TAILWATER MIGHT INFLUENCE HEADWATER ON 00250
C  SLOPE CULVERT                                                        00251
C                                                                       00252
      IF (HW3.GT.HW4) GO TO 603                                         00253
      BWH=HW4                                                           00254
      VO=V4                                                             00255
      GO TO 900                                                         00256
603   BWH=HW3                                                           00257
      VO=V3                                                             00258
      GO TO 900                                                         00259
C                                                                       00260
C HEADWATER CALCULATION FOR TAILWATER GREATER THAN CRITICAL DEPTH BUT LE00261
C HIGH  (SLOPE LESS THAN CRITICAL SLOPE)                                00262
C                                                                       00263
```

```
  700 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)                  00264**8
      IF (TW-UDEP) 801,701,702                                            00265
701   D5=UDEP                                                             00266
      WDEP=UDEP                                                           00267
      GO TO 703                                                           00268
  702 CALL BWM1(SHAPE,TW,DIFT,WIFT,QPP,MANN,SLOPE,LENGTH,UDEP,WDEP)       00269**8
      D5=WDEP                                                             00270
703   CALL AREAH                                                           00271
      V=QPP/ARC                                                           00272
      BWH=(1.+KECF)*V**2/64.4+WDEP                                        00273
      D5=TW                                                               00274
      CALL AREAH                                                           00275
      VO=QPP/ARC                                                          00276
      GO TO 900                                                           00277
C                                                                         00278
C HEADWATER CALCULATION BASED ON OUTLET CONTROL - PARTIAL FLOW (CRITICAL00279
C  DEPTH CONTROL)                                                         00280
C                                                                         00281
  800 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)                00282**8
  801 CALL BWM2(TW,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLOPE,LENGTH,UDEP,      00283**8
     . WDEP,D5,DIST,HIFT)                                                 00284**8
      IF (DIST.LT.LENGTH) GO TO 802                                       00285
      D5=WDEP                                                             00286
804   CALL AREAH                                                           00287
      V=QPP/ARC                                                           00288
      HE=(1.+KECF)*V**2/64.4                                              00289
      BWH=WDEP+HE                                                         00290
      GO TO 805                                                           00291
803   D5=UDEP                                                             00292
      GO TO 804                                                           00293
C                                                                         00294
C 0.9257*HIGH REPRESENTS DEPTH RATIO IN ARCH PIPE SHAPE AT WHICH CONVEYA00295
C  IS MAXIMUM                                                             00296
C                                                                         00297
  802 IF(WDEP.LT.0.9257*HIFT) GO TO 803                                   00298**8
      D5=HIFT                                                             00299**8
      CALL AREAH                                                           00300
      CALL WETPR                                                          00301
      R=ARC/WPR                                                           00302
      SF=SLOP(QPP,MANN,ARC,R)                                             00303
      V=QPP/ARC                                                           00304
      HF=(LENGTH-DIST)*(SF-SLOPE)                                         00305
      HE=(1.+KECF)*V**2/64.4                                              00306
      BWH=HIFT+HE+HF                                                      00307**8
805   UDEP=AMAX1(TW,CRITD)                                                00308
      D5=UDEP                                                             00309
      CALL AREAH                                                           00310
      VO=QPP/ARC                                                          00311
C                                                                         00312
C PREPARATION FOR OUTPUT                                                  00313
C                                                                         00314
900   IBBLS=BBLS                                                          00315
      IDIAM=0                                                             00316
      IF(MAT.NE.3) IWIDE=WIFT*12.                                         00317**8
      ILEN=LENGTH                                                         00318
      IF(MAT.NE.3) IHIGH=HIFT*12.                                         00319**8
      OUTEL1=OUTEL+SLOPE*(ABS(OUTSTA-OUTST1))                             00320
```

```
      INEL1=INEL-SLOPE*(ABS(INSTA-INSTA1))
      BWHEL=BWH+INEL1
      IF (KC(64).NE.1.OR.MAT.EQ.3) GO TO 910
C
C ESTIMATED COST CALCULATION
C
      CALL IINDEX(J,HIFT,ITYP)
      CALL PIPCOS (J)
910   FLAG=BLANK
      IF (MAT.EQ.3) FLAG=STAR(KC(34))
      HWC=BWHEL
      VEC=VO
CDEL  WRITE (SYSOUT,4311) IBBLS,IDIAM,IWIDE,IHIGH,ILEN,MAXHW,BWHEL,BWH,
CDEL 1 VMAX,VO,TOTCOS,FLAG
 4311 FORMAT(2X,I3,I8,3(I7),F10.2,F9.2,F7.2,2(F8.2),2X,F7.0,1X,A)
C
C THE GENERAL AIM OF THIS ROUTINE IS TO BEST SATISFY ALLOWABLE HEADWATER
C AT THE SAME TIME, FIND A HEADWATER WHICH SUBMERGES THE CULVERT SOFFIT
C
      IF (BWH.LE.MAXHW1) GO TO 901
      IF (KC(26).EQ.1) GO TO 902
      IF (KC(22).EQ.1) GO TO 904
      IF (NUSE.EQ.NR) GO TO 904
      IF (MAT.NE.3) GO TO 908
      IF (NUSE+3.LE.NR) NUSE=NUSE+2
908   NUSE=NUSE+1
      IF (RISE(NUSE).LE.DEPTH) GO TO 110
      NUSE=NUSE-1
904   BBLS=BBLS+1.
      KC(23)=1
      GO TO 203
C
C RECALL STORED VALUES FOR THE LAST TRIAL SIZE
C
902   VO=VOK
      BWH=BWHK
      BBLS=NBBLS
      WIDE=NWIDE
      HIGH=NHIGH
      LENGTH=NLEN
      INEL1=ELNK
      OUTEL1=ELOK
      INSTA1=STNK
      OUTST1=STOK
CDEL  WRITE (SYSOUT,1001) NBBLS,NWIDE,NHIGH,NLEN
1001  FORMAT (/2X,'****  BARRELS=',I3,'  WIDE=',I4,'  HIGH=',I4,'  LENGT
     1H=',I4,'  IS THE ACCEPTED DESIGN  ****')
903   KC(26)=0
      KC(24)=0
      KC(22)=0
      KC(23)=0
      DIAM=0
      DIFT=0.
CDEL  IF (MAT.EQ.3) WRITE (SYSOUT,1004)
1004  FORMAT (///2X,'* 18 INCH RADIUS'/2X,'** 31 INCH RADIUS')
      RETURN
901   IF (NUSE.EQ.NS) GO TO 906
```

```
      IF (MAT.NE.3) GO TO 907                                           00376
      IF (NUSE-3.GE.NS) NUSE=NUSE-2                                     00377
907   NUSE=NUSE-1                                                       00378
      IF(BWH.LT.HIFT) GO TO 905                                         00379**8
C                                                                       00380
C STORE VALUES FOR CURRENT TRIAL SIZE IN CASE IT IS THE MOST EFFICIENT  00381
C HYDRAULICALLY                                                         00382
C                                                                       00383
      NBBLS=IBBLS                                                       00384
      NHIGH=IHIGH                                                       00385
      NLEN=ILEN                                                         00386
      NWIDE=IWIDE                                                       00387
      VOK=VO                                                            00388
      BWHK=BWH                                                          00389
      ELNK=INEL1                                                        00390
      ELOK=OUTEL1                                                       00391
      STNK=INSTA1                                                       00392
      STOK=OUTST1                                                       00393
      KC(26)=1                                                          00394
      GO TO 110                                                         00395
905   KC(22)=1                                                          00396
      GO TO 110                                                         00397
906   IF (KC(23).EQ.1) GO TO 903                                        00398
      IF (BBLS.NE.1.0) GO TO 909                                        00399
CDEL  IF (MAT.EQ.3) WRITE (SYSOUT,1005)                                 00400
1005  FORMAT(// 63H0CLB0085--THIS IS THE SMALLEST STRUCTURAL PLATE SIZE 00401**2
     $AVAILABLE. )                                                      00402**2
      WIDE=IWIDE                                                        00403
      GO TO 903                                                         00404
909   BBLS=BBLS-1.                                                      00405
      GO TO 203                                                         00406
911   RETURN                                                            00407**9
      END                                                               00408
      SUBROUTINE RC18 (INSTA1,OUTST1,INEL1,OUTEL1,BWHEL,*)              00001*14
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH,      00002*14
     1 KECF1,INSTA1,MAXHW1,INEL1                                        00003*14
      INTEGER SHAPE,PROFIL,OPENGS                                       00004**9
      COMMON/COSCOM/PRC(90),CONC,STL,FILLH,CMISC,COSFT,TOTCOS           00005
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),        00006
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00007**9
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00008
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00009
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00010
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00011*13
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00012
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00013
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00015**9
      CHARACTER*4 EXES                                                  00016*14
      DIMENSION ACO(6),EXES(2)                                          00017
      DATA EXES/'    ','XXXX'/                                          00018
      SLOP(A,X,Y,D)=A**2*X**2/(2.208*Y**2*D**(4./3.))                   00019
C                                                                       00020
C     THIS ROUTINE DESIGNS A SINGLE-OPENING, STRAIGHT, NORMAL, BOX      00021
C     CULVERT                                                           00022
C                                                                       00023
100   KFLAG=0                                                           00024
      KECF1=KECF                                                        00025
```

```
      KC(40)=0
      KC(61)=0
      JFLAG=0
      BWHK=0.
      SLOPE=(INEL-OUTEL)/ABS(OUTSTA-INSTA)
      LC=12
      TW=WATEL-OUTEL
      IF(TW.LT.0.0) TW=0.0
      IF (MANN.EQ.1.0) MANN=0.012
      LFLAG=0
      WTKEEP=0.
      WT=0.
      MAXHW1=MAXHW-INEL
      IF (MAXHW1.GE.DEPTH) GO TO 101
      HIFT=MAXHW1/(1.2-SLOPE*UPSS)+0.5
      GO TO 102
  101 HIFT=DEPTH
  102 IF(HIFT.GT.10.0) HIFT=10.0
      IF(HIFT.LT.2.0) HIFT=2.0
      HIFT=IFIX(HIFT)
      HIGH=HIFT*12.
  104 MAXHW1=MAXHW-INEL+HIFT*UPSS*SLOPE
105   WTA=WT
C
C SUBROUTINE SPANS INSURES CONFORMITY TO THD STANDARD CULVERT SHAPES
C
      CALL SPANS(HIFT,MAXHW1,QPEAK,KECF,BBLS,WIFT,JFLAG,WT)
      WIDE=WIFT*12.
      IF (WT.NE.WTA) WTKEEP=WTKEEP+(WT-WTA)
      QPP=QPEAK/BBLS
      QPFT=QPP/WIFT
      CRITD=(QPFT**2/32.2)**(1./3.)
      IF(CRITD.LT.HIFT) GO TO 108
      ADD=AMAX1(HIFT,TW)
      INSTA1=INSTA
      OUTST1=OUTSTA
      IF (INSTA1.LT.OUTST1) GO TO 121
      INSTA1=INSTA1-HIFT*UPSS
      OUTST1=OUTST1+HIFT*DNSS
      GO TO 122
  121 INSTA1=INSTA1+HIFT*UPSS
      OUTST1=OUTST1-HIFT*DNSS
122   LENGTH=ABS(INSTA1-OUTST1)
      CALL BOXUD (SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
      IF (UDEP.LT.HIFT) GO TO 200
      GO TO 500
  108 A=WIFT*CRITD
      WP=WIFT+2.*CRITD
      R=A/WP
      CRSLPE=SLOP(QPP,MANN,A,R)
      INSTA1=INSTA
      OUTST1=OUTSTA
      IF (INSTA1.LT.OUTST1) GO TO 201
      INSTA1=INSTA1-HIFT*UPSS
      OUTST1=OUTST1+HIFT*DNSS
      GO TO 202
  201 INSTA1=INSTA1+HIFT*UPSS
```

```
      OUTST1=OUTST1-HIFT*DNSS
202   LENGTH=ABS(INSTA1-OUTST1)
C
C TESTS FOR PROPER CALCULATION METHOD
C
      IF (SLOPE.LT.CRSLPE) GO TO 203
200   IF (TW.LE.SLOPE*LENGTH) GO TO 300
      IF(TW.GT.(SLOPE*LENGTH+HIFT)) GO TO 204
      IF (TW.LT.SLOPE*LENGTH+CRITD) GO TO 300
      IF(TW.LT.HIFT) GO TO 205
      KFLAG=4
      GO TO 300
203   IF (CRITD.GT.TW) GO TO 700
      IF(TW.GT.HIFT) GO TO 204
      GO TO 600
204   ADD=TW
      GO TO 500
205   ADD=WATEL-INEL
      VENT=QPP/(ADD*WIFT)
      BWH=ADD+(1.+KECF)*VENT**2/64.4
      GO TO 309
C
C ENTRANCE CONTROL HEADWATER CALCULATION
C
300   IF (KECF.EQ.0.15.OR.KECF.EQ.0.4) GO TO 308
      IF (KECF.EQ.0.5) GO TO 301
      ACO(1)=0.144138
      ACO(2)=0.461363
      ACO(3)=-0.0921507
      ACO(4)=0.0200028
      ACO(5)=-0.00136449
      ACO(6)=0.0000358431
      GO TO 302
301   ACO(1)=0.122117
      ACO(2)=0.505435
      ACO(3)=-0.108560
      ACO(4)=0.0207809
      ACO(5)=-0.00136757
      ACO(6)=0.0000345642
      GO TO 302
308   ACO(1)=0.0724927
      ACO(2)=0.507087
      ACO(3)=-0.117474
      ACO(4)=0.0221702
      ACO(5)=-0.00148958
      ACO(6)=0.0000380126
  302 XENT=(QPP/WIFT)/HIFT**1.5
      HWOD=ACO(1)
      P=1.
      DO 303 J=2,6
       P=P*XENT
       HWOD=HWOD+ACO(J)*P
303   CONTINUE
      BWH=HWOD*HIFT
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
      IF(UDEP.EQ.HIFT) GO TO 306
C
```

```
C CHECK FOR HYDRAULIC JUMP
C
C     IF CRITD GREATER THAN HIFT, CALL BWS2 W HIFT
C
      CRITKP=CRITD
      IF (CRITD.GT.HIFT) CRITD=HIFT
      CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,D5,
     1 *813)
      CRITD=CRITKP
      A=WIFT*D5
      D2=-D5/2.+SQRT(2.*QPP**2/(D5*WIFT)**2*D5/32.2+D5**2/4.)
      IF(D2.LT.HIFT) GO TO 305
      A2=HIFT*WIFT
      D2=QPP**2/(32.2*A2)*(1./A-1./A2)+A/A2*D5/2.+0.5*HIFT
305   IF (D2.GT.TW) GO TO 307
      IF(TW.GT.HIFT) GO TO 306
  309 A=WIFT*TW
      GO TO 304
  306 A=WIFT*HIFT
C
C KFLAG=4 WHEN HEADWATER MAY BE ENTRANCE OR OUTLET CONTROL
C
      IF (UDEP.EQ.HIFT) KFLAG=4
      GO TO 304
  307 A=WIFT*D5
304   VO=QPP/A
      IF (KFLAG.NE.4) GO TO 800
      V3=VO
      HW3=BWH
      IF (TW.GE.HIFT) GO TO 402
      P1=(CRITD+HIFT)/2.
      IF (P1.GE.TW) GO TO 403
402   P1=TW
403   KFLAG=4
      ADD=P1
      GO TO 500
404   HW4=BWH
      V4=QPP/A
      IF (HW3.GT.HW4) GO TO 405
      VO=V4
      GO TO 800
405   BWH=HW3
      VO=V3
      GO TO 800
C
C FULL FLOW - OUTLET CONTROL HEADWATER CALCULATION
C
  500 A=HIFT*WIFT
      WP=2.*(HIFT+WIFT)
      R=A/WP
      VO=QPP/A
      HE=(1.+KECF1)*VO**2/64.4
      HF=LENGTH*SLOP(QPP,MANN,A,R)
      BWH=ADD+HE+HF-SLOPE*LENGTH
      IF (KFLAG.NE.4) GO TO 800
      IF(TW.GE.HIFT) GO TO 503
      IF (TW.GT.CRITD) GO TO 505
```

```
      IF(CRITD.GT.HIFT) GO TO 503
      A=CRITD*WIFT
      GO TO 404
  505 A=TW*WIFT
      GO TO 404
  503 A=HIFT*WIFT
      GO TO 404
C
C HEADWATER CALCULATION FOR TAILWATER GREATER THAN CRITICAL DEPTH BUT LE
C HIGH.  (SLOPE LESS THAN CRITICAL SLOPE)
C
  600 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
      IF (TW-UDEP) 701,601,602
601   WDEP=UDEP
      GO TO 603
  602 CALL BWM1(SHAPE,TW,DIFT,WIFT,QPP,MANN,SLOPE,LENGTH,UDEP,WDEP)
  603 A=WDEP*WIFT
      V=QPP/A
      BWH=(1.+KECF)*V**2/64.4+WDEP
      VO=QPP/(WIFT*TW)
      GO TO 800
C
C HEADWATER CALCULATION FOR TAILWATER LESS THAN CRITICAL DEPTH AND UNIFO
C DEPTH.  (SLOPE LESS THAN CRITICAL SLOPE)
C
  700 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
  701 CALL BWM2(TW,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLOPE,LENGTH,UDEP,
     . WDEP,D5,DIST,HIFT)
      IF (DIST.LT.LENGTH) GO TO 702
      D4=WDEP
  703 V=QPP/(WIFT*D4)
      HE=(1.+KECF)*V**2/64.4
      BWH=WDEP+HE
      GO TO 707
  702 IF(WDEP.GE.HIFT) GO TO 705
      D4=UDEP
      GO TO 703
  705 A=WIFT*HIFT
      WP=2.*(WIFT+HIFT)
      R=A/WP
      V=QPP/A
      HF=(LENGTH-DIST)*(SLOP(QPP,MANN,A,R)-SLOPE)
      HE=(1.+KECF)*V**2/64.4
      BWH=HIFT+HE+HF
  707 VO=QPP/(WIFT*AMIN1(HIFT,AMAX1(TW,CRITD)))
800   IF (JFLAG.EQ.0) WTKEEP=WT
      IF (BWH.GT.MAXHW1.AND.WT.LT.WTKEEP) GO TO 810
C
C UP TO 75 TRIAL SIZES ALLOWED
C
      IF (KC(40).LT.75) GO TO 803
CDEL  WRITE (SYSOUT,1001)
1001  FORMAT (  76H CLB0086--THE CONDITIONS FOR THIS BOX DESIGN CANNOT B
     $E REASONABLY SATISFIED.  )
      KC(61)=1
      GO TO 811
803   IDIAM=0
```

```
      IHIGH=HIFT                                                        00254*13
      IWIDE=WIFT                                                        00255*13
      IBBLS=BBLS                                                        00256
      ILEN=LENGTH                                                       00257
      BWHK=BWH                                                          00258
      VOK=VO                                                            00259
      INEL1=INEL-SLOPE*ABS(INSTA-INSTA1)                                00260
      BWHEL=BWH+INEL1                                                   00261
C                                                                       00262
C COST CALCULATION                                                      00263
C                                                                       00264
      IF (KC(64).EQ.1) CALL COST                                        00265
      IF (LC.LT.48) GO TO 805                                           00266
      LC=8                                                              00267
CDEL  CALL PAGE                                                         00268*10
CDEL  WRITE (SYSOUT,4310)                                               00269
 4310 FORMAT (//2X,'BBLS   DIAM   WIDE   HIGH   LENGTH   ALLOW.   CALC. 00270*10
     1  CALC.   ALLOW.   CALC.'/37X,'HW ELEV  HW ELEV   HW     VELOC.   00271*10
     2.  VELOC.'/)                                                      00272*10
805   CONTINUE
      HWC=BWHEL
      VEC=VO
CDEL  WRITE (SYSOUT,4311) IBBLS,IDIAM,IWIDE,IHIGH,ILEN,MAXHW,BWHEL,BWH, 00273
CDEL 1 VMAX,VO,TOTCOS,EXES(KC(68)+1)                                    00274
4311  FORMAT(2X,I3,I8,I7,I7,I7,F10.2,F9.2,F7.2,F8.2,F8.2,2X,F7.0,2X,A1) 00275
      LC=LC+1                                                           00276
      KC(40)=KC(40)+1                                                   00277
C                                                                       00278
C COMPARE CALCULATED HEADWATER WITH ALLOWABLE HEADWATER                 00279
C                                                                       00280
      IF (BWH.LE.MAXHW1) GO TO 801                                      00281
      WT=WT+1.                                                          00282
      JFLAG=1                                                           00283
      GO TO 105                                                         00284
C                                                                       00285
C SMALLEST BOX SIZE AVAILABLE                                           00286
C                                                                       00287
  801 IF(BBLS.LE.1.0.AND.HIFT.LE.2.0.AND.WIFT.LE.3.0) GO TO 809         00288*13
C                                                                       00289
C BOX IS SIZED UPON COMPARISON OF BWH AND MAXHW1 ACCORDING TO WHETHER TH00290
C CURRENT WIDTH (WT) WAS AN INCREASE OR DECREASE OF THE PREVIOUS TRIAL  00291
C WIDTH (WTKEEP)                                                        00292
C                                                                       00293
      IF (WT.GT.WTKEEP) GO TO 811                                       00294
      IF (LFLAG.EQ.1) GO TO 812                                         00295
      IF (BWH.GT.MAXHW1-.5) GO TO 811                                   00296
      LFLAG=1                                                           00297
  812 IF(WIFT.GT.HIFT) GO TO 802                                        00298*13
      IF (BBLS.LE.2.) GO TO 804                                         00299
      IF(HIFT.LE.7.) GO TO 802                                          00300*13
804   JFLAG=0                                                           00301
      HIFT=HIFT-1.                                                      00302*13
      GO TO 104                                                         00303
802   WT=WT-1.                                                          00304
      JFLAG=-1                                                          00305
      GO TO 105                                                         00306
809   CONTINUE
```

```
CDEL  WRITE (SYSOUT,1002)
1002  FORMAT (  61H CLB0087--THIS IS THE SMALLEST BOX SIZE AVAILABLE.  T
     $RY PIPE.  )
      GO TO 811
810   BBLS=IBBLS
      WIFT=IWIDE
      HIFT=IHIGH
      LENGTH=ILEN
      BWH=BWHK
      VO=VOK
811   INEL1=BWHEL-BWH
      OUTEL1=OUTEL+SLOPE*ABS(OUTSTA-OUTST1)
      WIDE=WIFT*12.
      HIGH=HIFT*12.
      RETURN
  813 RETURN 1
      END
      SUBROUTINE RC3 (*)
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH
      INTEGER OPENGS,PROFILE,SHAPE
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE
      CHARACTER*3 CLVTID,BRSUB,NAME,ROADID
      CHARACTER*4 FLSEC,ORIGID,MOVEID,TOID,GSEC,CONYID,NAM,
     1 IS1,IS2,IDSEC,BLANK4
      COMMON/CCOM1/BRSUB(10),CLVTID,FLSEC,NAME,ORIGID,ROADID
      COMMON/ID/MOVEID,TOID,GSEC(50),CONYID,NAM,IS1,IS2,IDSEC(50)
      COMMON/XSECT/FLAG1(50),EX(100,50),WY(100,50)
      DIMENSION X(100),Y(100)
      DATA BLANK4/'    '/
C
C THIS ROUTINE CHECKS THAT CERTAIN NECESSARY DATA HAS BEEN PROVIDED, THE
C  GETS THE SECTION FROM EXTERNAL STORAGE AND THEN CALLS THE CORRECT
C SUBROUTINE
C
100   CONTINUE
      IF (FLSEC.NE.BLANK4)GO TO 53
CDEL  WRITE (SYSOUT,1003)
1003  FORMAT (  67H CLB0088--NO CROSS-SECTION IDENTIFICATION GIVEN.  (SE
     $E FL-DV CARD.)     )
      GO TO 703
53    DO 50 N=1,50
       J=N
       IF (FLSEC.EQ.IDSEC(J)) GO TO 51
50    CONTINUE
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (  70H CLB0089--THERE IS NO CROSS-SECTION ID FROM HYDRA WHI
     $CH CORRESPONDS TO         /
     2          10X, 37HFLOW-DIVIDE SECX.  PROBLEM ABANDONED.  )
      GO TO 703
```

```
51    NPTS=NTOTPT(J)
      DO 1799 I=1,100
      X(I)=EX(I,J)
 1799 Y(I)=WY(I,J)
C
C  REVERSE THE LIMITS AND SLOPES IF THE ORIGINAL SECTION WAS IN DESCENDI
C ORDER
C
      KC(35)=FLAG1(J)
      NO=KC(7)
      IF (KC(35).NE.1) GO TO 1807
      DO 1808 N=1,NO
      TEMP=LFTSS(N)
      LFTSS(N)=RGTSS(N)
      RGTSS(N)=TEMP
      TEMP=FROMX(N)
      FROMX(N)=TOX(N)
1808  TOX(N)=TEMP
1807  IF (KC(8).EQ.1) GO TO 1800
      DO 1803 N=1,NO
       RGTSS(N)=2.
1803  LFTSS(N)=2.
CDEL  WRITE (SYSOUT,1001)
1001  FORMAT (  82H CLB0090--VALUE FOR LEFT AND RIGHT HEADER SLOPES NOT
     $GIVEN.  2.0 ASSUMED FOR BOTH. )
1800  IF (OPENGS.NE.1) GO TO 1805
      IF(KC(28).EQ.1) GO TO 801
      IF (KC(2).NE.1) GO TO 1802
C
C SINGLE BRIDGE ANALYSIS
C
 801  CALL RC8 (X,Y,J,NPTS)
      GO TO 1806
C
C  SINGLE BRIDGE DESIGN
C
 1802 CALL RC4 (X,Y,NPTS,J,ADUM,KDUM,LDUM,X2DUM,Y2DUM,SDUM,EDUM)
      GO TO 1806
1805  IF (KC(7).EQ.OPENGS) GO TO 1801
CDEL  WRITE (SYSOUT,54)
54    FORMAT (  80H CLB0091--MULTIPLE BRIDGE REQUESTED, BUT NUMBER OF FL
     $OW-DIVIDES NOT EQUAL TO THE  /
     2      10X,           29HNUMBER OF OPENINGS SPECIFIED.  )
      GO TO 703
 1801 KSET=NSUBSC(J)
      DO 1818 K=1,KSET
      IF (ISECN(J,5*K-2).EQ.-999999.9) GO TO 1820
 1818 CONTINUE
      GO TO 1804
 1820 CONTINUE
CDEL  WRITE(SYSOUT,55) FLSEC
  55  FORMAT(' CLB0113--MULTIPLE BRIDGE DESIGN NOT FEASIBLE.',/,10X,
     1  'NO N VALUE SUPPLIED FOR SECTION ',A,'.')
      GO TO 703
C
C  MULTIPLE BRIDGE DESIGN
C
```

```
1804   CALL RC6 (X,Y,J)
      IF(KC(11).EQ.1)GO TO 703
1806  IF (KC(35).NE.1) GO TO 1809
      DO 1810 N=1,NO
      TEMP=LFTSS(N)
      LFTSS(N)=RGTSS(N)
      RGTSS(N)=TEMP
      TEMP=FROMX(N)
      FROMX(N)=TOX(N)
1810  TOX(N)=TEMP
1809  RETURN
703   RETURN1
      END
      SUBROUTINE RC4(X,Y,NPTS,J,ANEED,KKEEP,LKEEP,X2KEEP,Y2KEEP,
     1 STAR,END)
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH
      INTEGER SHAPE,PROFIL,OPENGS
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE
      DIMENSION X(100),Y(100)
C
C     THIS ROUTINE DESIGNS ONE OPENING OF A BRIDGE
C
C ANEED REPRESENTS THE MINIMUM CROSS-SECTION AREA NEEDED TO SATISFY DESI
C
100   ANEED=QPEAK/VMAXB(1)
      KSTAR=0
      KC(23)=0
      NO=1
C
C FIND THE BEGIN AND END POINTS OF THE FL-DV
C
54    KSTAR=KSTAR+1
      IF (X(KSTAR).LT.FROMX(1)) GO TO 54
55    IF (X(NPTS).LE.TOX(1)) GO TO 200
      NPTS=NPTS-1
      GO TO 55
C
C ENTRY POINT FOR DESIGN OF ONE OPENING OF A MULTIPLE OPENING BRIDGE-FRO
C
      ENTRY RC4B (X,Y,NPTS,J,ANEED,KKEEP,LKEEP,X2KEEP,Y2KEEP,NNO,
     1 STAR,END)
      NO = NNO
      KSTAR=1
  200 LKEEP = 0
      KWAY=1
      NAR=1
      BKEEP=10000.
      SUMC=0.
      XKP=X(NPTS)
```

```
C
C ADJUST VARIABLES ACCORDING TO WHETHER AREAS ARE TO BE ACCUMULATED ACRO
C THE SECTION FROM LEFT TO RIGHT, OR RIGHT TO LEFT
C
201   KC(11)=0
      IF (KWAY.NE.1) GO TO 209
      KK=KSTAR
      VSIDE=RGTSS(NO)
      FSIDE=LFTSS(NO)
      MINUS=NPTS-1
      GO TO 202
209   KK=NPTS
      FSIDE=RGTSS(NO)
      VSIDE=LFTSS(NO)
      MINUS=KSTAR+1
C
C BEGIN INDIVIDUAL (AND ACCUMULATIVE) AREA AND WIDTH CALCULATIONS
C
C REINITIALIZE THE VARIABLES AFTER A SOLUTION HAS BEEN FOUND
C
202   LL=1
      SUMA=0.
      SUMB=0.
      JLAG=0
      N=KK
C
C ESTABLISH THE DIMENSIONS OF A TRAPEZOID
C
203   X1=X(N)
      Y1=Y(N)
      X2=X(N+KWAY)
      Y2=Y(N+KWAY)
      H1=WATEL-Y1
      H2=WATEL-Y2
      XTMP=ABS(X2-X1)
      HT=AMAX1(H2,0.)
      AA=HT*HT*VSIDE/2.
      SMBTMP=SUMB
      SMATMP=SUMA
C
C BOTH ADJACENT POINTS UNDER WATER
C
      IF (H1.GE.0.0.AND.H2.GE.0.0) GO TO 205
C
C ONE OR OTHER ADJACENT POINT UNDER WATER
C
      IF (H1.LT.0.0.AND.H2.GT.0.0) GO TO 206
      IF (H1.GT.0.0.AND.H2.LT.0.0) GO TO 207
C
C NEITHER ADJACENT POINT UNDER WATER
C
      A=0.
      B=0.
      IF (JLAG.NE.0) GO TO 212
      XTMP=0.
      KK=KK+KWAY
      LL=1
```

```
      GO TO 212
C
C COMPUTE THE SUBMERGED AREA OF THE TRAPEZOID
C
205   B=XTMP
      A=B*(H1+H2)/2.
      GO TO 208
206   IF(KC(11).EQ.0)GO TO 210
CDEL  WRITE(SYSOUT,1003)WATEL
1003  FORMAT(' CLB0113--AT WATER SURFACE ELEVATION ',F8.2,' ANOTHER FLOW
     1 DIVIDE MUST BE DEFINED.')
      RETURN
210   B=H2*XTMP/(H2-H1)
      A=B*H2/2.
      X1=X2-(KWAY*B)
      Y1=WATEL
      GO TO 208
207   B=H1*XTMP/(H1-H2)
      A=B*H1/2.
      X2=X1+(KWAY*B)
      Y2=WATEL
C
C  AT THIS POINT THE STREAM CROSS SECTION EMERGES. KC(11)=1
C
      KC ( 11 ) = 1
C
208   KPLL=LL
      XKP=X2
      IF (JLAG.NE.0) GO TO 212
C
C ADD IN THE AREA OF THE TRIANGLE AT THE BEGINNING END OF THE SECTION
C
      HT=AMAX1(H1,0.)
      SUMA=HT*FSIDE*HT/2.
      SUMB=HT*FSIDE
      SMATMP=SUMA
      SMBTMP=SUMB
      XTMP=B
      JLAG=1
212   SUMA=SUMA+A
      IF ( KC(11) .EQ. 1 ) GO TO 215
      SUMB = SUMB + XTMP
      GO TO 216
215   SUMB = SUMB + B
216   IF ( KWAY .NE. 1 ) GO TO 300
      IF (NAR.GT.N) GO TO 300
C
C AREA FOR THE TOTAL SECTION IS ACCUMULATED
C
      SUMC=SUMC+A
      NAR=NAR+1
C
C CHECK WHETHER THE ACCUMULATED AREA IS SUFFICIENT TO SATISFY THE DESIGN
C  CRITERIA
C
C
C CHECK IF THIS AREA GIVES A BETTER DESIGN (SHORTER) AND STORE VALUES IF
```

```
C
 300  ATEST=SUMA+AA
      IF(ATEST.LT.ANEED)GO TO 301
      H1=WATEL-Y1
      DX=X2-X1
      DY=Y2-Y1
      ICOUNT=1
 302  IF(ABS(ATEST-ANEED).LT.0.1) GO TO 303
      DX=DX*0.5
      DY=DY*0.5
      ADJ=1.0
      IF(ANEED.LE.ATEST) ADJ=-1.0
      X2=X2+ADJ*DX
      Y2=Y2+ADJ*DY
      B=ABS(X2-X1)
      H2=WATEL-Y2
      AA=H2*H2*VSIDE/2.0
      ATEST=SMATMP+B*(H1+H2)*0.5+AA
      ICOUNT=ICOUNT+1
      IF(ICOUNT.LE.15) GO TO 302
 303  SUMB=SMBTMP+B+H2*VSIDE
      IF (SUMB.GE.BKEEP) GO TO 304
      LKEEP = KPLL
      KKEEP = KK
      SUMAK=ATEST
      X2KEEP=X2
      Y2KEEP=Y2
      BKEEP=SUMB
      KC(32)=KWAY
304   KK=KK+KWAY
C
C CHECK IF ALL POINTS HAVE BEEN USED
C
      IF (KK.NE.MINUS) GO TO 202
      IF (KWAY.NE.1) GO TO 400
      KWAY=-1
      GO TO 201
C
C IF ALL POINTS HAVE NOT BEEN USED, INCREMENT THE COUNTERS AND
C PROCESS THE NEXT TRAPEZOID
C
301   IF (N.EQ.MINUS) GO TO 305
      LL=LL+1
      N=N+KWAY
      GO TO 203
C
C ALL POINTS HAVE BEEN USED, SO CHECK THAT A SOLUTION HAS BEEN FOUND.
C IF SO, REVERSE THE PROCESS AND GO FROM RIGHT TO LEFT
C
  305 IF(LKEEP.EQ.0) GO TO 307
      IF (KWAY.NE.1) GO TO 400
      KWAY=-1
      GO TO 201
C
C NO SOLUTION FOUND, BUT STORE VARIABLES FOR LATER USE
C
  307 KKEEP = KK
```

```
      X2KEEP=XKP
      Y2KEEP=Y2
      BKEEP=SUMB
      KC(32)=1
      LKEEP = KPLL
      SUMAK=SUMA
C
C MANIPULATE THE VARIABLES TO SHOW BOUNDARIES OF THE STRUCTURE
C
 400  SUMA=SUMAK
      SUMA=SUMAK
      IF (KC(32).NE.1.AND.KC(35).EQ.0) GO TO 401
      IF (KC(32).EQ.1.AND.KC(35).EQ.1) GO TO 401
      STAR = X(KKEEP)
      END=X2KEEP
      GO TO 402
401   STAR=X2KEEP
      END = X(KKEEP)
  402 IF(KC(32).NE.1) KKEEP = KKEEP - LKEEP
      LEN(NO)=BKEEP
C                             RESET KC(11) BEFORE RETURNING
      KC ( 11 ) = 0
C
C RETURN FOR MULTIPLE BRIDGE DESIGN
C
      IF (KC(23).EQ.1) RETURN
C
C FINAL VELOCITY AND BACKWATER HEAD CALCULATIONS
C
      ANEED=SUMAK
      VELOC(1)=QPEAK/SUMA
      VELOC(2)=QPEAK/SUMC
      BWH=(VELOC(1)**2-VELOC(2)**2)/64.4
CDEL  IF (VELOC(1).LT.VMIN(1)) WRITE (SYSOUT,1001)
1001  FORMAT (  78H CLB0092--CALCULATED VELOCITY IS LESS THAN MINIMUM VE
     $LOCITY.  SUGGEST BREAKING   /
     2            10X,     40HDESIGN SECTION INTO MORE X AND Y POINTS. )
C
C NATURAL VELOCITY IS GREATER THAN INPUT MAXIMUM VELOCITY
C
CDEL  IF (VELOC(1).GT.VMAXB(1)) WRITE (SYSOUT,1002)
1002  FORMAT (  80H CLB0093--CALCULATED VELOCITY EXCEEDS INPUT MAXIMUM V
     $ELOCITY.  SUGGEST THAT THIS   /
     2   10X,    71HMAX VELOCITY IS UNREALISTIC FOR THIS COMBINATION OF
     3Q, WATER ELEVATION,     /
     4   10X,    19HAND DESIGN SECTION.  )
C
C GO TO PRINT BRIDGE DESIGN REPORT
C
CDEL  CALL BRRPT (STAR,END,J)
      IF(KC(27).EQ.0) RETURN
      FROMX(1)=STAR
      TOX(1)=END
      RETURN
      END
      SUBROUTINE RC40(BWHEL,QPPE,CRITDE,TWE,*)
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LENGTH,LFTSS
```

```
      INTEGER SHAPE,PROFIL,OPENGS
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE
      DIMENSION ACO(6)
C
C     THIS ROUTINE ANALYZES A STRAIGHT, NORMAL, CIRCULAR,
C     SINGLE-OPENING CULVERT.
C
100   TW=WATEL-OUTEL
      SLOPE=(INEL-OUTEL)/ABS(INSTA-OUTSTA)
      QPP=QPEAK/BBLS
      ITYP=1
C
C N VALUE ASSIGNMENT
C
      GO TO (101,102,103), MAT
      GO TO 104
101   MANN=0.012
      GO TO 104
102   MANN=0.024
      ITYP=2
      IF(DIFT.GT.8.0) MANN=0.027
      IF(DIFT.GT.10.0) GO TO 103
      GO TO 104
  103 WES=(ALOG10(DIFT+10.)-4.15076)/(-5.77698)-2.
      MANN=10.**WES
C
C DETERMINATION OF CRITICAL DEPTH AND CRITICAL SLOPE
C
  104 CALL CRITIC(QPP,DIFT,CRITD,CRSLPE,MANN)
      LENGTH=ABS(INSTA-OUTSTA)
C
C TEST FOR PROPER HEADWATER CALCULATION METHOD
C
      IF (SLOPE.LT.CRSLPE) GO TO 203
      IF (TW.LE.SLOPE*LENGTH) GO TO 300
      IF(TW.LE.(SLOPE*LENGTH+DIFT)) GO TO 400
204   ADD=TW
      GO TO 500
      ENTRY CULNOR(BWHEL,QPPE,CRITDE,TWE)
      QPP=QPPE
      CRITD=CRITDE
      TW=TWE
203   IF (CRITD.GT.TW) GO TO 700
      IF(TW.LT.DIFT) GO TO 600
      GO TO 204
C
C KFLAG=4 WHEN HEADWATER MAY BE ENTRANCE OR OUTLET CONTROL
C
400   KFLAG=4
```

```
300   IF (MANN.EQ.0.012) GO TO 307
      IF (KECF.EQ.0.2) KECF=0.5
      IF (KECF.EQ.0.7) GO TO 313
      IF (KECF.EQ.0.9) GO TO 314
C
C COEFFICIENTS FOR CGMP
C
      ACO(1)=0.167433
      ACO(2)=0.538595
      ACO(3)=-0.149374
      ACO(4)=0.0391543
      ACO(5)=-0.00343974
      ACO(6)=0.000115882
      GO TO 306
313   ACO(1)=0.107137
      ACO(2)=0.757789
      ACO(3)=-0.361462
      ACO(4)=0.123393
      ACO(5)=-0.0160642
      ACO(6)=0.000767390
      GO TO 306
314   ACO(1)=0.187321
      ACO(2)=0.567710
      ACO(3)=-0.156544
      ACO(4)=0.0447052
      ACO(5)=-0.00343602
      ACO(6)=0.000089661
      GO TO 306
307   IF (KECF.EQ.0.2) GO TO 308
      IF (KECF.EQ.0.25) GO TO 309
      IF (KECF.EQ.0.55) GO TO 310
C
C COEFFICIENTS FOR RCP
C
      ACO(1)=0.087483
      ACO(2)=0.706578
      ACO(3)=-0.253295
      ACO(4)=0.0667001
      ACO(5)=-0.00661651
      ACO(6)=0.000250619
      GO TO 306
310   ACO(1)=0.167287
      ACO(2)=0.558766
      ACO(3)=-0.159813
      ACO(4)=0.0420069
      ACO(5)=-0.00369252
      ACO(6)=0.000125169
      GO TO 306
309   ACO(1)=0.108786
      ACO(2)=0.662381
      ACO(3)=-0.233801
      ACO(4)=0.0579585
      ACO(5)=-0.00557890
      ACO(6)=0.000205052
      GO TO 306
308   ACO(1)=0.114099
      ACO(2)=0.653562
```

```
      ACO(3)=-0.233615
      ACO(4)=0.0597723
      ACO(5)=-0.00616338
      ACO(6)=0.000242832
C
C SOLVE FOR HEADWATER BY FORMULA FOR EMPIRICAL CURVE OF ENTRANCE CONTROL
C HEADWATER
C
  306 XENT=QPP/DIFT**2.5
      HWOD=ACO(1)
      P=1.
      DO 301 J=2,6
       P=P*XENT
       HWOD=HWOD+ACO(J)*P
301   CONTINUE
      BWH=HWOD*DIFT
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
      IF(UDEP.NE.FLOAT(IFIX((100.*DIFT)*.93818)/100)) GO TO 311
      D5=UDEP
      GO TO 312
  311 CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,D5,
     1 *802)
C
C CHECK FOR HYDRAULIC JUMP
C
      CALL JUMP(D5,DIFT,QPP,D2,CRITD,MANN)
      IF (D2.GT.TW) GO TO 312
      D5=AMIN1(TW,DIFT)
  312 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)
      VO=QPP/A
      IF (KFLAG.NE.4) GO TO 800
      V3=VO
      HW3=BWH
      ADD=AMAX1(TW,CRITD)
C
C FULL FLOW OUTLET CONTROL HEADWATER
C
  500 D5=DIFT
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)
      VO=QPP/A
      HE=(1.+KECF)*VO**2/64.4
      HF=LENGTH*S
      BWH=ADD+HE+HF-SLOPE*LENGTH
      D5A=AMAX1(TW,CRITD)
      D5=AMIN1(DIFT,D5A)
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)
      VO=QPP/A
      IF (KFLAG.NE.4) GO TO 800
      IF(TW.GE.DIFT) GO TO 502
      D5=AMAX1(TW,CRITD)
      GO TO 503
  502 D5=DIFT
  503 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)
      V4=QPP/A
      HW4=BWH
C
C SELECT LARGEST HEADWATER WHERE TAILWATER MIGHT INFLUENCE HEADWATER
```

```
C  ON STEEP SLOPE CULVERT
C
      IF (HW3.GT.HW4) GO TO 405
      BWH=HW4
C
C BWH BASED ON OUTLET CONTROL
C
      VO=V4
      GO TO 800
405   BWH=HW3
      VO=V3
      GO TO 800
  600 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)              **8
      IF (TW-UDEP) 701,601,602
  602 CALL BWM1(SHAPE,TW,DIFT,WIFT,QPP,MANN,SLOPE,LENGTH,UDEP,WDEP)     **8
      D5=WDEP
      GO TO 603
601   D5=UDEP
      WDEP=UDEP
  603 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 **8
      V=QPP/A
      BWH=(1.+KECF)*V**2/64.4+WDEP
      D5=TW
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 **8
      VO=QPP/A
      GO TO 800
C
C HEADWATER CALCULATION FOR OUTLET CONTROL BY CRITICAL DEPTH.  (NOT FULL
C
  700 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)              **8
  701 CALL BWM2(TW,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLOPE,LENGTH,UDEP,    **8
     . WDEP,D5,DIST,HIFT)                                               **8
      IF (DIST.LT.LENGTH) GO TO 702
      IF (KC(21).EQ.1) GO TO 708                                        **9
      D5=WDEP
  703 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 **8
      V=QPP/A
      HE=(1.+KECF)*V**2/64.4
      BWH=WDEP+HE
      GO TO 706
705   D5=UDEP
      GO TO 703
  702 IF(WDEP.LT.0.93818*DIFT) GO TO 705                                **8
  708 D5=DIFT                                                           **9
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 **8
      V=QPP/A
      HF=(LENGTH-DIST)*(S-SLOPE)
      HE=(1.+KECF)*V**2/64.4
      BWH=DIFT+HE+HF                                                    **8
706   D5=AMAX1(TW,CRITD)
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 **8
      VO=QPP/A
800   BWHEL=BWH+INEL
      IF (KC(64).NE.1) GO TO 801
C
C ESTIMATED COST CALCULATION
C
```

```
      CALL IINDEX(J,DIFT,ITYP)                                          00231**8
      CALL PIPCOS(J)                                                    00232
  801 DIAM=DIFT*12.                                                     00233**8
      RETURN                                                            00234
  802 RETURN 1                                                          00235**9
      END                                                               00236
      SUBROUTINE RC40FLP(BWHEL,QPPE,CRITDE,TWE,*)
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LENGTH,LFTSS       00002
      INTEGER SHAPE,PROFIL,OPENGS                                       00003**5
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00004
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00005
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),        00006
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00007**5
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00008**3
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00009**8
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00010**3
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00011**3
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00012**5
      DIMENSION ACO(6)                                                  00013
C                                                                       00014
C     THIS ROUTINE ANALYZES A STRAIGHT, NORMAL, CIRCULAR,               00015
C     SINGLE-OPENING CULVERT.                                           00016
C                                                                       00017
100   TW=WATEL-OUTEL                                                    00018
      SLOPE=(INEL-OUTEL)/ABS(INSTA-OUTSTA)                              00019
      QPP=QPEAK/BBLS                                                    00020
      ITYP=1                                                            00021
C
C ITYP=1 FOR RCP; ITYP=2 FOR CGMP
C
C TWV IS THE EFFECTIVE TW ACCOUNTING FOR HEAD LOSS DUE TO A
C DOWNSTREAM VALVE.
C
C THIS FIRST SET OF CALCULATIONS ASSUMES THAT THE FLOW DEPTH AT THE
C DOWNSTREAM END OF THE CULVERT IS CONTROLLED BY THE TAILWATER.  THUS,
C FOR SOME OF THE SUBSEQUENT CALCULATIONS, THE VALUE OF TWV NEEDS TO
C BE RECOMPUTED.

C FOR TW BELOW SOFFIT, GO TO 990.
C
C     ICULFLAG=0
  980 CONTINUE
      IF(TWSOFF.GT.0.) GO TO 990
C
C FOR FULL FLOW DUE TO TW SUBMERGENCE, ADD HEAD LOSS DUE TO GATE, AND
C ADJUST TW TO HIGHER EFFECTIVE VALUE.
C
 985  AREA=3.141592*DIFT**2/4
      V=QPP/AREA
      XKFLAP=8.*EXP(-1.15*V/SQRT(DIFT))
      DTW=XKFLAP*V**2/64.4
      TWV=TW+DTW
      TWVFULL=TWV
C     IF(ICULFLAG.EQ.1)GOTO 203
      GOTO 1010
 990  CONTINUE
C
```

```
C FOR TW BELOW DOWNSTREAM SOFFITT INTERPOLATE HEADLOSS
C                                                                       00022
      TWV=TW+((TW/TWSOFF)**2)*(VWSOFF-TWSOFF)
C
 1010 CONTINUE
C N VALUE ASSIGNMENT                                                    00023
C                                                                       00024
      GO TO (101,102,103), MAT                                          00025
      GO TO 104                                                         00026
101   MANN=0.012                                                        00027
      GO TO 104                                                         00028
102   MANN=0.024                                                        00029
      ITYP=2                                                            00030
      IF(DIFT.GT.8.0) MANN=0.027                                        00031**8
      IF(DIFT.GT.10.0) GO TO 103                                        00032**8
      GO TO 104                                                         00033
  103 WES=(ALOG10(DIFT+10.)-4.15076)/(-5.77698)-2.                      00034**8
      MANN=10.**WES                                                     00035
C                                                                       00036
C DETERMINATION OF CRITICAL DEPTH AND CRITICAL SLOPE                    00037
C                                                                       00038
  104 CALL CRITIC(QPP,DIFT,CRITD,CRSLPE,MANN)                           00039**8
      LENGTH=ABS(INSTA-OUTSTA)                                          00040
C                                                                       00041
C TEST FOR PROPER HEADWATER CALCULATION METHOD                          00042
C                                                                       00043
C FOR MILD SLOPES, GO TO 203
C
      IF (SLOPE.LT.CRSLPE) GO TO 203                                    00044
C
C FOR STEEP AND CRITICAL SLOPES, BRANCH DEPENDING ON TW POSITION.  THE
C ONLY DIFFERENCE BETWEEN GOING TO 300 AND GOING TO 400 IS THAT KFLAG
C FOR OLD TYPE 4 IS SET TO 4 WHEN GOING TO 400.
C
      IF (TWV.LE.SLOPE*LENGTH) GO TO 300                                00045
      IF (TWV.LE.(SLOPE*LENGTH+DIFT)) GO TO 400                         00046**8
C
C 204 IS FOR FULL FLOW FOR EITHER MILD OR STEEP SLOPES
C
204   ADD=TWV                                                           00047
      GO TO 500                                                         00048
C
C CULNOR IS ONLY FOR MILD SLOPES (USED ONLY AT LINE 78 IN RC41).
C
C     ENTRY CULNORF(BWHEL,QPPE,CRITDE,TWE)                              00049**9
C     QPP=QPPE                                                          00050**9
C     CRITD=CRITDE                                                      00051**9
C     TW=TWE                                                            00052**9
C     ICULFLAG=1
C     GOTO 980
C
C GOTO 700 IS FOR M2 CURVE WITH LOW TWV.
C
  203 CONTINUE
C
      IF (CRITD.GT.TWV) GO TO 700                                       00053
C
```

```
C GOTO 600 IS FOR M1 CURVE AND FOR M2 CURVE WITH TWV BETWEEN CRITC AND
C UDEP.
C
      IF (TWV.LT.DIFT) GO TO 600                                        00054**8
      GO TO 204                                                         00055
C                                                                       00056
C BRANCH TO THIS POINT (400) FOR STEEP OR CRITICAL SLOPES AND TW
C BETWEEN UPSTREAM INVERT AND UPSTREAM SOFFITT (OLD TYPE 4).
C KFLAG=4 WHEN HEADWATER MAY BE ENTRANCE OR OUTLET CONTROL              00057
C                                                                       00058
400   KFLAG=4                                                           00059

C
C BRANCH TO THIS POINT (300) FOR STEEP OR CRITICAL SLOPES WITH TW LOWER
C THAN UPSTREAM INVERT.
C
C FOLLOWING CALCULATIONS ALSO FOR STEEP OR CRITICAL SLOPES WITH TW
C BETWEEN UPSTREAM INVERT AND UPSTREAM SOFFITT (OLD TYPE 4).
C
C THUS, THESE CALCULATIONS ARE FOR STEEP OR CRITICAL SLOPES WITH ANY TW
C LOWER THAN UPSTREAM SOFFITT.
C
300   IF (MANN.EQ.0.012) GO TO 307                                      00060
      IF (KECF.EQ.0.2) KECF=0.5                                         00061
      IF (KECF.EQ.0.7) GO TO 313                                        00062
      IF (KECF.EQ.0.9) GO TO 314                                        00063
C                                                                       00064
C COEFFICIENTS FOR CGMP                                                 00065
C                                                                       00066
      ACO(1)=0.167433                                                   00067
      ACO(2)=0.538595                                                   00068
      ACO(3)=-0.149374                                                  00069
      ACO(4)=0.0391543                                                  00070
      ACO(5)=-0.00343974                                                00071
      ACO(6)=0.000115882                                                00072
      GO TO 306                                                         00073
313   ACO(1)=0.107137                                                   00074
      ACO(2)=0.757789                                                   00075
      ACO(3)=-0.361462                                                  00076
      ACO(4)=0.123393                                                   00077
      ACO(5)=-0.0160642                                                 00078
      ACO(6)=0.000767390                                                00079
      GO TO 306                                                         00080
314   ACO(1)=0.187321                                                   00081
      ACO(2)=0.567710                                                   00082
      ACO(3)=-0.156544                                                  00083
      ACO(4)=0.0447052                                                  00084
      ACO(5)=-0.00343602                                                00085
      ACO(6)=0.000089661                                                00086
      GO TO 306                                                         00087
307   IF (KECF.EQ.0.2) GO TO 308                                        00088
      IF (KECF.EQ.0.25) GO TO 309                                       00089
      IF (KECF.EQ.0.55) GO TO 310                                       00090
C                                                                       00091
C COEFFICIENTS FOR RCP                                                  00092
C                                                                       00093
      ACO(1)=0.087483                                                   00094
```

```
      ACO(2)=0.706578                                                   00095
      ACO(3)=-0.253295                                                  00096
      ACO(4)=0.0667001                                                  00097
      ACO(5)=-0.00661651                                                00098
      ACO(6)=0.000250619                                                00099
      GO TO 306                                                         00100
310   ACO(1)=0.167287                                                   00101
      ACO(2)=0.558766                                                   00102
      ACO(3)=-0.159813                                                  00103
      ACO(4)=0.0420069                                                  00104
      ACO(5)=-0.00369252                                                00105
      ACO(6)=0.000125169                                                00106
      GO TO 306                                                         00107
309   ACO(1)=0.108786                                                   00108
      ACO(2)=0.662381                                                   00109
      ACO(3)=-0.233801                                                  00110
      ACO(4)=0.0579585                                                  00111
      ACO(5)=-0.00557890                                                00112
      ACO(6)=0.000205052                                                00113
      GO TO 306                                                         00114
308   ACO(1)=0.114099                                                   00115
      ACO(2)=0.653562                                                   00116
      ACO(3)=-0.233615                                                  00117
      ACO(4)=0.0597723                                                  00118
      ACO(5)=-0.00616338                                                00119
      ACO(6)=0.000242832                                                00120
C                                                                       00121
C SOLVE FOR HEADWATER BY FORMULA FOR EMPIRICAL CURVE OF ENTRANCE CONTROL00122
C HEADWATER                                                             00123
C                                                                       00124
  306 XENT=QPP/DIFT**2.5                                                00125**8
      HWOD=ACO(1)                                                       00126
      P=1.                                                              00127
      DO 301 J=2,6                                                      00128
       P=P*XENT                                                         00129
       HWOD=HWOD+ACO(J)*P                                               00130
301   CONTINUE                                                          00131
      BWH=HWOD*DIFT                                                     00132**8
C
C CALCULATE NORMAL DEPTH (UDEP) AND CHECK WHETHER IT IS AT THE RELATIVE
C DEPTH (0.938) FOR MAXIMUM Q.  IF IT IS, SET D5 = NORMAL DEPTH.  SINCE
C THE STARTING DEPTH AT THE UPSTREAM END IS CRITICAL DEPTH AND THESE
C CALCULATIONS ARE FOR A STEEP SLOPE, THEN CRITICAL DEPTH DIVIDED BY
C DIFT MUST BE GREATER THAN 0.93818.  THUS, IT IS APPARENTLY BEING
C ASSUMED FOR THIS CASE THAT THE S2 CURVE WILL REACH NORMAL DEPTH SO
C THE S2 SURVE IS NOT BEING CALCULATED.  GOING TO 312 ALSO SKIPS OVER
C THE PART HTA CHECKS FOR A POSSIBLE HYDRAULIC JUMP.  STILL, IT IS NOT
C CLEAR WHY THIS APPROACH IS USED ONLY FOR UDEP/DIFT .EQ. 0.938 AND NOT
C FOR UDEP/DIFT .GE. 0.938.  PERHAPS THE GRADUALLY VARIED FLOW
C COMPUTATIONS ARE UNSTABLE NEAR NORMAL DEPTH FOR UDEP/DIFT = 0.938.
C IF UDEP/DIFT .NE. 0.938, THEN CALCULATE THE S2 CURVE AND CHECK FOR A
C HYDRAULIC JUMP.
C
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)              00133**8
      IF(UDEP.NE.FLOAT(IFIX((100.*DIFT)*.93818)/100)) GO TO 311         00134**8
      D5=UDEP                                                           00135
      GO TO 312                                                         00136
```

```
  311 CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,D5,    00137**9
     1 *802)                                                            00138**9
C                                                                       00139
C CHECK FOR HYDRAULIC JUMP.  D5 IS THE DEPTH AT THE DOWNSTREAM END OF   00140
C THE CULVERT.  D2 IS CONJUGATE TO D5.                                  00141
C
      CALL JUMP(D5,DIFT,QPP,D2,CRITD,MANN)                              00142**8
C
C IF D2 .GT. TWV, THEN A JUMP CANNOT FORM, SO D5 STAYS THE SAME AS
C ABOVE.  OTHERWISE, THE DEPTH AT THE DOWNSTREAM END IS TAKEN AS THE
C SMALLER OF TWV AND DIFT.
C
      IF (D2.GT.TWV) GO TO 312                                          00143
      D5=AMIN1(TWV,DIFT)                                                00144**8
  312 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00145**8
C
C VO = OUTLET VELOCITY.
C
      VO=QPP/A                                                          00146
      IF (KFLAG.NE.4) GO TO 800                                         00147
C
C CONTINUE HERE ONLY FOR OLD TYPE 4 FLOW.  OTHERWISE, GO TO THE END OF
C THE PROGRAM (800).
C
      V3=VO                                                             00148
      HW3=BWH                                                           00149
      ADD=AMAX1(TWV,CRITD)                                              00150
C                                                                       00151
C FULL FLOW OUTLET CONTROL HEADWATER(BOTH SUBMERGED OUTLET & OLD TYPE 4)00152
C                                                                       00153
  500 D5=DIFT                                                           00154**8
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00155**8
      VO=QPP/A                                                          00156
      HE=(1.+KECF)*VO**2/64.4                                           00157
      HF=LENGTH*S                                                       00158
      BWH=ADD+HE+HF-SLOPE*LENGTH                                        00159
C
C SET DEPTH AT THE DOWNSTREAM END OF THE CULVERT AS SMALLER OF DIFT AND
C TWV OR SMALLER OF DIFT AND CRITD IF CRITD > TWV.  CAN COME TO THIS
C POINT FOR EITHER SUBMERGED OUTLETS OR FOR OLD TYPE 4 FLOWS.
C
      D5A=AMAX1(TWV,CRITD)                                              00160
      D5=AMIN1(DIFT,D5A)                                                00161**8
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00162**8
      VO=QPP/A                                                          00163
      IF (KFLAG.NE.4) GO TO 800                                         00164
C
C CONTINUE HERE ONLY FOR OLD TYPE 4.
C
      IF(TWV.GE.DIFT) GO TO 502                                         00165**8
      D5=AMAX1(TWV,CRITD)                                               00166
      GO TO 503                                                         00167
  502 D5=DIFT                                                           00168**8
  503 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00169**8
      V4=QPP/A                                                          00170
      HW4=BWH                                                           00171
C                                                                       00172
```

```
C SELECT LARGEST HEADWATER WHERE TAILWATER MIGHT INFLUENCE HEADWATER    00173
C ON STEEP SLOPE CULVERT (OLD TYPE 4)                                   00174
C                                                                       00175
      IF (HW3.GT.HW4) GO TO 405                                         00176
      BWH=HW4                                                           00177
C                                                                       00178
C BWH BASED ON OUTLET CONTROL                                           00179
C                                                                       00180
      VO=V4                                                             00181
      GO TO 800                                                         00182
405   BWH=HW3                                                           00183
      VO=V3                                                             00184
      GO TO 800                                                         00185
C
C BRANCH HERE FOR M1 CURVE AND FOR M2 CURVE WITH TWV BETWEEN CRITC AND
C UDEP.
C
  600 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)              00186**8
C
C GOTO 701 FOR M2 CURVE WITH TWV BETWEEN CRITC AND UDEP.
C
      IF (TWV-UDEP) 701,601,602                                         00187
C
C CALCULATE M1 CURVE.
C
  602 CALL BWM1(SHAPE,TWV,DIFT,WIFT,QPP,MANN,SLOPE,LENGTH,UDEP,WDEP)    00188**8
      D5=WDEP                                                           00189
      GO TO 603                                                         00190
C
C BRANCH TO HERE ONLY FOR DOWNSTREAM DEPTH = UDEP.
C
601   D5=UDEP                                                           00191
      WDEP=UDEP                                                         00192
  603 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00193**8
      V=QPP/A                                                           00194
C
C CALCULATE HEADWATER BY ADDING UPSTREAM VELOCITY HEAD AND ENTRANCE
C LOSS TO UPSTREAM DEPTH.
C
      BWH=(1.+KECF)*V**2/64.4+WDEP                                      00195
C
C CALCULATE OUTLET VELOCITY (VO).
C
      D5=TWV                                                            00196
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00197**8
      VO=QPP/A                                                          00198
      GO TO 800                                                         00199
C                                                                       00200
C HEADWATER CALCULATION FOR OUTLET CONTROL BY CRITICAL DEPTH (NOT FULL) 00201
C AND FOR TWV BETWEEN CRITD AND UDEP.  BWM2 DETERMINES CORRECT STARTING
C DEPTH OF EITHER CRITD OR TWV.
C                                                                       00202
  700 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)              00203**8
C
C CALCULATE M2 CURVE.
C
  701 CALL BWM2(TWV,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLOPE,LENGTH,UDEP,   00204**8
```

```
     . WDEP,D5,DIST,HIFT)                                               00205**8
C
C WDEP IS DEPTH AT UPSTREAM END OF CULVERT.
C
C IF M2 CURVE REACHED UDEP BEFORE UPSTREAM END OF CULVERT, GO TO 702.
C
      IF (DIST.LT.LENGTH) GO TO 702                                     00206
      IF (KC(21).EQ.1) GO TO 708                                        00207**9
C
C CALCULATE HEADWATER BY ADDING UPSTREAM VELOCITY HEAD AND ENTRANCE
C LOSS TO UPSTREAM DEPTH.
C
      D5=WDEP                                                           00208
  703 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00209**8
      V=QPP/A                                                           00210
      HE=(1.+KECF)*V**2/64.4                                            00211
      BWH=WDEP+HE                                                       00212
      GO TO 706                                                         00213
705   D5=UDEP                                                           00214
      GO TO 703                                                         00215
C
C BRANCH TO HERE IF M2 CURVE REACHED UDEP BEFORE UPSTREAM END OF
C CULVERT.  THEN, IF WDEP IS BELOW 0.93818*DIFT, GO BACK TO CALCULATE
C HEADWATER BASED ON UDEP.
C
  702 IF(WDEP.LT.0.93818*DIFT) GO TO 705                                00216**8
C
C IF WDEP IS ABOVE 0.93818*DIFT, ASSUME THAT CULVERT IS FULL AT THE
C UPSTREAM END.  HF IS THE DIFFERENCE BETWEEN THE FRICTION HEAD LOSS AND
C THE DROP OF THE INVERT BETWEEN THE UPSTREAM END AND THE POINT AT WHICH
C THE CALCULATION OF THE M2 CURVE STOPPED.
C
  708 D5=DIFT                                                           00217**9
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00218**8
      V=QPP/A                                                           00219
      HF=(LENGTH-DIST)*(S-SLOPE)                                        00220
      HE=(1.+KECF)*V**2/64.4                                            00221
      BWH=DIFT+HE+HF                                                    00222**8
C
C CALCULATE OUTLET VELOCITY (VO).
C
706   D5=AMAX1(TWV,CRITD)                                               00223
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00224**8
      VO=QPP/A                                                          00225
800   BWHEL=BWH+INEL                                                    00226
      IF (KC(64).NE.1) GO TO 801                                        00227
C                                                                       00228
C ESTIMATED COST CALCULATION                                            00229
C                                                                       00230
      CALL IINDEX(J,DIFT,ITYP)                                          00231**8
      CALL PIPCOS(J)                                                    00232
  801 DIAM=DIFT*12.                                                     00233**8
      RETURN                                                            00234
  802 RETURN 1                                                          00235**9
      END                                                               00236
      SUBROUTINE RC40FLX(BWHEL,QPPE,CRITDE,TWE,*)
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LENGTH,LFTSS       00002
```

```
      INTEGER SHAPE,PROFIL,OPENGS                                       00003**5
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00004
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00005
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),        00006
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00007**5
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00008**3
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00009**8
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00010**3
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00011**3
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00012**5
      DIMENSION ACO(6)                                                  00013
C                                                                       00014
C     THIS ROUTINE ANALYZES A STRAIGHT, NORMAL, CIRCULAR,               00015
C     SINGLE-OPENING CULVERT WITH FLEX GATE.                            00016
C
100   TW=WATEL-OUTEL                                                    00018
      SLOPE=(INEL-OUTEL)/ABS(INSTA-OUTSTA)                              00019
      QPP=QPEAK/BBLS                                                    00020
      ITYP=1                                                            00021
C
C ITYP=1 FOR RCP; ITYP=2 FOR CGMP
C
C TWV IS THE EFFECTIVE TW ACCOUNTING FOR HEAD LOSS DUE TO A
C DOWNSTREAM VALVE.
C
C THIS FIRST SET OF CALCULATIONS ASSUMES THAT THE FLOW DEPTH AT THE
C DOWNSTREAM END OF THE CULVERT IS CONTROLLED BY THE TAILWATER.  THUS,
C FOR SOME OF THE SUBSEQUENT CALCULATIONS, THE VALUE OF TWV NEEDS TO
C BE RECOMPUTED.

C FOR TW BELOW SOFFIT, GO TO 990.
C
C     ICULFLAG=0
 980  IF(QSOFF.GT.0.) GOTO 990
C
C FOR FULL FLOW DUE TO TW SUBMERGENCE, ADD HEAD LOSS DUE TO GATE, AND
C ADJUST TW TO HIGHER EFFECTIVE VALUE.
C
 985  AREA=3.141593*DIFT**2/4.
C
      AHALF=0.5*AREA
      QHALF=11.34*AHALF
      QOQH=QPP/QHALF
      IF(QOQH.GE.0.036)AVALV=
     .AHALF*(0.9127+0.9277*ALOG10(QOQH)+(0.09059/(QOQH**0.5967)))
      IF(QOQH.LT.0.036)AVALV=
     .AHALF*(0.9127+0.9277*ALOG10(0.036)+(0.09059/(0.036**0.5967)))
     .*(QOQH/0.036)
C
      VHDV=((QPP/AVALV)**2)/64.4
      VHDP=((QPP/AREA)**2)/64.4
C
      TWV=TW+2.*(VHDV-VHDP)
C
      TWVFULL=TWV
C     IF(ICULFLAG.EQ.1)GOTO 203
      GOTO 1010
```

```
C
C FOR TW BELOW DOWNSTREAM SOFFITT, DO TRIAL AND ERROR SOLUTION OF
C ENERGY EQUATION TO GET DEPTH (TWV) IN CULVERT JUST UPSTREAM OF GATE
C ASSUMING THAT THE DEPTH AT THE DOWNSTREAM END OF THE CULVERT WOULD
C BE TW IF THERE WERE NO GATE PRESENT.
C
 990  CONTINUE
C
      YEXIT=AMAX1(DIFT*HWXC/HSOFF,TW)
C
      HFT=0.137*DIFT*12.
      YVEXIT=YEXIT+(HFT-DIFT)/2.
C
      AREA=3.141593*DIFT**2/4.
C
      AHALF=0.5*AREA
      QHALF=11.34*AHALF
C
      QSOQH=QSOFF/QHALF
C
      IF(QSOQH.GE.0.036)ASOFF=
     .AHALF*(0.9127+0.9277*ALOG10(QSOQH)+(0.09059/(QSOQH**0.5967)))
      IF(QSOQH.LT.0.036)ASOFF=
     .AHALF*(0.9127+0.9277*ALOG10(0.036)+(0.09059/(0.036**0.5967)))
     .*(QSOQH/0.036)
C
      AVALV=ASOFF*(YEXIT/DIFT)
C
      BTRI=2.*AVALV/HFT
C
      IF(YVEXIT.LT.HFT/2.)THEN
         TEXIT=BTRI*YVEXIT/(0.5*HFT)
         AEXIT=TEXIT*YVEXIT/2.
         ELSE
         TEXIT=BTRI*(HFT-YVEXIT)/(0.5*HFT)
         AEXIT=AVALV-TEXIT*(HFT-YVEXIT)/2.
      ENDIF
C
      VEXIT=QPP/AEXIT
      VHDX=(VEXIT**2)/64.4
C
      CALL CRITIC(QPP,DIFT,CRITD,CRSLPE,MANN)
      YC=CRITD
C
994   CONTINUE
      YMAX=DIFT
      YMIN=YC
      RHS=YEXIT+2.*VHDX
      RIFT=DIFT/2.
      DO 995 IY=1,25
      YTRY=(YMAX+YMIN)/2.
      IF(YTRY.LE.RIFT)THEN
         X=RIFT-YTRY
         S=SQRT(RIFT*RIFT-X*X)
         THETA=2.*ASIN(S/RIFT)
         ATRY=THETA*RIFT*RIFT/2.-X*S
      ELSE
```

```
         X=YTRY-RIFT
         S=SQRT(RIFT*RIFT-X*X)
         THETA=2.*ASIN(S/RIFT)
         ATRY=3.141593*RIFT*RIFT-THETA*RIFT*RIFT/2.+X*S
      ENDIF
      XLHS=YTRY+((QPP/ATRY)**2)/32.2
      IF(ABS(RHS-XLHS).LE.1.E-03)GO TO 997
      IF(DIFT-YTRY.LT.1.E-03)GO TO 996
      IF(RHS.LT.XLHS)THEN
         YMAX=YTRY
      ELSE
         YMIN=YTRY
      ENDIF
995   CONTINUE
      WRITE(*,9995)
      WRITE(6,9995)
9995  FORMAT(1X,'WARNING 995: TIDEFLEX VALVE TAILWATER ENERGY DNC. ')
      GO TO 1010
996   CONTINUE
      VHDP=(QPP/AREA)**2/64.4
      VHDX=(QPP/AVALV)**2/64.4
      TWV=YEXIT+2.*(VHDX-VHDP)
      GO TO 1010
997   CONTINUE
      TWV=YTRY
C
C
 1000 CONTINUE
C
C CHECK FOR LACK OF CONVERGENCE BECAUSE PIPE IS FULL DUE TO HEAD
C LOSS EVEN THOUGH TW IS BELOW SOFFITT.
C
 1010 CONTINUE
C
C N VALUE ASSIGNMENT
C
      GO TO (101,102,103), MAT
      GO TO 104
101   MANN=0.012
      GO TO 104
102   MANN=0.024
      ITYP=2
      IF(DIFT.GT.8.0) MANN=0.027
      IF(DIFT.GT.10.0) GO TO 103
      GO TO 104
  103 WES=(ALOG10(DIFT+10.)-4.15076)/(-5.77698)-2.
      MANN=10.**WES
C
C DETERMINATION OF CRITICAL DEPTH AND CRITICAL SLOPE
C
  104 CALL CRITIC(QPP,DIFT,CRITD,CRSLPE,MANN)
      LENGTH=ABS(INSTA-OUTSTA)
C
C TEST FOR PROPER HEADWATER CALCULATION METHOD
C
C FOR MILD SLOPES, GO TO 203
C
```

```
      IF (SLOPE.LT.CRSLPE) GO TO 203                                    00044
C
C FOR STEEP AND CRITICAL SLOPES, BRANCH DEPENDING ON TW POSITION.  THE
C ONLY DIFFERENCE BETWEEN GOING TO 300 AND GOING TO 400 IS THAT KFLAG
C FOR OLD TYPE 4 IS SET TO 4 WHEN GOING TO 400.
C
      IF (TWV.LE.SLOPE*LENGTH) GO TO 300                                00045
      IF (TWV.LE.(SLOPE*LENGTH+DIFT)) GO TO 400                         00046**8
C
C 204 IS FOR FULL FLOW FOR EITHER MILD OR STEEP SLOPES
C
204   ADD=TWV                                                           00047
      GO TO 500                                                         00048
C
C CULNOR IS ONLY FOR MILD SLOPES (USED ONLY AT LINE 78 IN RC41).
C
C     ENTRY CULNORX(BWHEL,QPPE,CRITDE,TWE)                              00049**9
C     QPP=QPPE                                                          00050**9
C     CRITD=CRITDE                                                      00051**9
C     TW=TWE                                                            00052**9
C     ICULFLAG=1
C     GOTO 980
203   CONTINUE
C
 1110 CONTINUE
C
C GOTO 700 IS FOR M2 CURVE WITH LOW TWV.
C
      IF (CRITD.GT.TWV) GO TO 700                                       00053
C
C GOTO 600 IS FOR M1 CURVE AND FOR M2 CURVE WITH TWV BETWEEN CRITC AND
C UDEP.
C
      IF (TWV.LT.DIFT) GO TO 600                                        00054**8
      GO TO 204                                                         00055
C                                                                       00056
C BRANCH TO THIS POINT (400) FOR STEEP OR CRITICAL SLOPES AND TW
C BETWEEN UPSTREAM INVERT AND UPSTREAM SOFFITT (OLD TYPE 4).
C KFLAG=4 WHEN HEADWATER MAY BE ENTRANCE OR OUTLET CONTROL              00057
C                                                                       00058
400   KFLAG=4                                                           00059

C
C BRANCH TO THIS POINT (300) FOR STEEP OR CRITICAL SLOPES WITH TW LOWER
C THAN UPSTREAM INVERT.
C
C FOLLOWING CALCULATIONS ALSO FOR STEEP OR CRITICAL SLOPES WITH TW
C BETWEEN UPSTREAM INVERT AND UPSTREAM SOFFITT (OLD TYPE 4).
C
C THUS, THESE CALCULATIONS ARE FOR STEEP OR CRITICAL SLOPES WITH ANY TW
C LOWER THAN UPSTREAM SOFFITT.
C
300   IF (MANN.EQ.0.012) GO TO 307                                      00060
      IF (KECF.EQ.0.2) KECF=0.5                                         00061
      IF (KECF.EQ.0.7) GO TO 313                                        00062
      IF (KECF.EQ.0.9) GO TO 314                                        00063
C                                                                       00064
```

```
C COEFFICIENTS FOR CGMP
C
      ACO(1)=0.167433
      ACO(2)=0.538595
      ACO(3)=-0.149374
      ACO(4)=0.0391543
      ACO(5)=-0.00343974
      ACO(6)=0.000115882
      GO TO 306
313   ACO(1)=0.107137
      ACO(2)=0.757789
      ACO(3)=-0.361462
      ACO(4)=0.123393
      ACO(5)=-0.0160642
      ACO(6)=0.000767390
      GO TO 306
314   ACO(1)=0.187321
      ACO(2)=0.567710
      ACO(3)=-0.156544
      ACO(4)=0.0447052
      ACO(5)=-0.00343602
      ACO(6)=0.000089661
      GO TO 306
307   IF (KECF.EQ.0.2) GO TO 308
      IF (KECF.EQ.0.25) GO TO 309
      IF (KECF.EQ.0.55) GO TO 310
C
C COEFFICIENTS FOR RCP
C
      ACO(1)=0.087483
      ACO(2)=0.706578
      ACO(3)=-0.253295
      ACO(4)=0.0667001
      ACO(5)=-0.00661651
      ACO(6)=0.000250619
      GO TO 306
310   ACO(1)=0.167287
      ACO(2)=0.558766
      ACO(3)=-0.159813
      ACO(4)=0.0420069
      ACO(5)=-0.00369252
      ACO(6)=0.000125169
      GO TO 306
309   ACO(1)=0.108786
      ACO(2)=0.662381
      ACO(3)=-0.233801
      ACO(4)=0.0579585
      ACO(5)=-0.00557890
      ACO(6)=0.000205052
      GO TO 306
308   ACO(1)=0.114099
      ACO(2)=0.653562
      ACO(3)=-0.233615
      ACO(4)=0.0597723
      ACO(5)=-0.00616338
      ACO(6)=0.000242832
C
```

```
C SOLVE FOR HEADWATER BY FORMULA FOR EMPIRICAL CURVE OF ENTRANCE CONTROL00122
C HEADWATER                                                             00123
C                                                                       00124
  306 XENT=QPP/DIFT**2.5                                                00125**8
      HWOD=ACO(1)                                                       00126
      P=1.                                                              00127
      DO 301 J=2,6                                                      00128
       P=P*XENT                                                         00129
       HWOD=HWOD+ACO(J)*P                                               00130
301   CONTINUE                                                          00131
      BWH=HWOD*DIFT                                                     00132**8
C
C CALCULATE NORMAL DEPTH (UDEP) AND CHECK WHETHER IT IS AT THE RELATIVE
C DEPTH (0.938) FOR MAXIMUM Q.  IF IT IS, SET D5 = NORMAL DEPTH.  SINCE
C THE STARTING DEPTH AT THE UPSTREAM END IS CRITICAL DEPTH AND THESE
C CALCULATIONS ARE FOR A STEEP SLOPE, THEN CRITICAL DEPTH DIVIDED BY
C DIFT MUST BE GREATER THAN 0.93818.  THUS, IT IS APPARENTLY BEING
C ASSUMED FOR THIS CASE THAT THE S2 CURVE WILL REACH NORMAL DEPTH SO
C THE S2 SURVE IS NOT BEING CALCULATED.  GOING TO 312 ALSO SKIPS OVER
C THE PART HTA CHECKS FOR A POSSIBLE HYDRAULIC JUMP.  STILL, IT IS NOT
C CLEAR WHY THIS APPROACH IS USED ONLY FOR UDEP/DIFT .EQ. 0.938 AND NOT
C FOR UDEP/DIFT .GE. 0.938.  PERHAPS THE GRADUALLY VARIED FLOW
C COMPUTATIONS ARE UNSTABLE NEAR NORMAL DEPTH FOR UDEP/DIFT = 0.938.
C IF UDEP/DIFT .NE. 0.938, THEN CALCULATE THE S2 CURVE AND CHECK FOR A
C HYDRAULIC JUMP.
C
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)              00133**8
      IF(UDEP.NE.FLOAT(IFIX((100.*DIFT)*.93818)/100)) GO TO 311         00134**8
      D5=UDEP                                                           00135
      GO TO 312                                                         00136
  311 CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,D5,    00137**9
     1 *802)                                                            00138**9
C                                                                       00139
C CHECK FOR HYDRAULIC JUMP.  D5 IS THE DEPTH AT THE DOWNSTREAM END OF   00140
C THE CULVERT.  D2 IS CONJUGATE TO D5.                                  00141
C
      CALL JUMP(D5,DIFT,QPP,D2,CRITD,MANN)                              00142**8
C
C IF D2 .GT. TWV, THEN A JUMP CANNOT FORM, SO D5 STAYS THE SAME AS
C ABOVE.  OTHERWISE, THE DEPTH AT THE DOWNSTREAM END IS TAKEN AS THE
C SMALLER OF TWV AND DIFT.
C
      IF (D2.GT.TWV) GO TO 312                                          00143
      D5=AMIN1(TWV,DIFT)                                                00144**8
  312 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00145**8
C
C VO = OUTLET VELOCITY.
C
      VO=QPP/A                                                          00146
      IF (KFLAG.NE.4) GO TO 800                                         00147
C
C CONTINUE HERE ONLY FOR OLD TYPE 4 FLOW.  OTHERWISE, GO TO THE END OF
C THE PROGRAM (800).
C
      V3=VO                                                             00148
      HW3=BWH                                                           00149
      ADD=AMAX1(TWV,CRITD)                                              00150
```

```
C                                                                       00151
C FULL FLOW OUTLET CONTROL HEADWATER(BOTH SUBMERGED OUTLET & OLD TYPE 4)00152
C                                                                       00153
  500 D5=DIFT                                                           00154**8
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00155**8
      VO=QPP/A                                                          00156
      HE=(1.+KECF)*VO**2/64.4                                           00157
      HF=LENGTH*S                                                       00158
      BWH=ADD+HE+HF-SLOPE*LENGTH                                        00159
C
C SET DEPTH AT THE DOWNSTREAM END OF THE CULVERT AS SMALLER OF DIFT AND
C TWV OR SMALLER OF DIFT AND CRITD IF CRITD > TWV.  CAN COME TO THIS
C POINT FOR EITHER SUBMERGED OUTLETS OR FOR OLD TYPE 4 FLOWS.
C
      D5A=AMAX1(TWV,CRITD)                                              00160
      D5=AMIN1(DIFT,D5A)                                                00161**8
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00162**8
      VO=QPP/A                                                          00163
      IF (KFLAG.NE.4) GO TO 800                                         00164
C
C CONTINUE HERE ONLY FOR OLD TYPE 4.
C
      IF(TWV.GE.DIFT) GO TO 502                                         00165**8
      D5=AMAX1(TWV,CRITD)                                               00166
      GO TO 503                                                         00167
  502 D5=DIFT                                                           00168**8
  503 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00169**8
      V4=QPP/A                                                          00170
      HW4=BWH                                                           00171
C                                                                       00172
C SELECT LARGEST HEADWATER WHERE TAILWATER MIGHT INFLUENCE HEADWATER    00173
C ON STEEP SLOPE CULVERT (OLD TYPE 4)                                   00174
C                                                                       00175
      IF (HW3.GT.HW4) GO TO 405                                         00176
      BWH=HW4                                                           00177
C                                                                       00178
C BWH BASED ON OUTLET CONTROL                                           00179
C                                                                       00180
      VO=V4                                                             00181
      GO TO 800                                                         00182
405   BWH=HW3                                                           00183
      VO=V3                                                             00184
      GO TO 800                                                         00185
C
C BRANCH HERE FOR M1 CURVE AND FOR M2 CURVE WITH TWV BETWEEN CRITC AND
C UDEP.
C
  600 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)              00186**8
C
C GOTO 701 FOR M2 CURVE WITH TWV BETWEEN CRITC AND UDEP.
C
      IF (TWV-UDEP) 701,601,602                                         00187
C
C CALCULATE M1 CURVE.
C
  602 CALL BWM1(SHAPE,TWV,DIFT,WIFT,QPP,MANN,SLOPE,LENGTH,UDEP,WDEP)    00188**8
      D5=WDEP                                                           00189
```

```
      GO TO 603                                                         00190
C
C BRANCH TO HERE ONLY FOR DOWNSTREAM DEPTH = UDEP.
C
601   D5=UDEP                                                           00191
      WDEP=UDEP                                                         00192
  603 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00193**8
      V=QPP/A                                                           00194
C
C CALCULATE HEADWATER BY ADDING UPSTREAM VELOCITY HEAD AND ENTRANCE
C LOSS TO UPSTREAM DEPTH.
C
      BWH=(1.+KECF)*V**2/64.4+WDEP                                      00195
C
C CALCULATE OUTLET VELOCITY (VO).
C
      D5=TWV                                                            00196
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00197**8
      VO=QPP/A                                                          00198
      GO TO 800                                                         00199
C                                                                       00200
C HEADWATER CALCULATION FOR OUTLET CONTROL BY CRITICAL DEPTH (NOT FULL) 00201
C AND FOR TWV BETWEEN CRITD AND UDEP.  BWM2 DETERMINES CORRECT STARTING
C DEPTH OF EITHER CRITD OR TWV.
C                                                                       00202
  700 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)              00203**8
C
C CALCULATE M2 CURVE.
C
  701 CALL BWM2(TWV,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLOPE,LENGTH,UDEP,   00204**8
     . WDEP,D5,DIST,HIFT)                                               00205**8
C
C WDEP IS DEPTH AT UPSTREAM END OF CULVERT.
C
C IF M2 CURVE REACHED UDEP BEFORE UPSTREAM END OF CULVERT, GO TO 702.
C
      IF (DIST.LT.LENGTH) GO TO 702                                     00206
      IF (KC(21).EQ.1) GO TO 708                                        00207**9
C
C CALCULATE HEADWATER BY ADDING UPSTREAM VELOCITY HEAD AND ENTRANCE
C LOSS TO UPSTREAM DEPTH.
C
      D5=WDEP                                                           00208
  703 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00209**8
      V=QPP/A                                                           00210
      HE=(1.+KECF)*V**2/64.4                                            00211
      BWH=WDEP+HE                                                       00212
      GO TO 706                                                         00213
705   D5=UDEP                                                           00214
      GO TO 703                                                         00215
C
C BRANCH TO HERE IF M2 CURVE REACHED UDEP BEFORE UPSTREAM END OF
C CULVERT.  THEN, IF WDEP IS BELOW 0.93818*DIFT, GO BACK TO CALCULATE
C HEADWATER BASED ON UDEP.
C
  702 IF(WDEP.LT.0.93818*DIFT) GO TO 705                                00216**8
C
```

```
C IF WDEP IS ABOVE 0.93818*DIFT, ASSUME THAT CULVERT IS FULL AT THE
C UPSTREAM END.  HF IS THE DIFFERENCE BETWEEN THE FRICTION HEAD LOSS AND
C THE DROP OF THE INVERT BETWEEN THE UPSTREAM END AND THE POINT AT WHICH
C THE CALCULATION OF THE M2 CURVE STOPPED.
C
  708 D5=DIFT                                                           00217**9
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00218**8
      V=QPP/A                                                           00219
      HF=(LENGTH-DIST)*(S-SLOPE)                                        00220
      HE=(1.+KECF)*V**2/64.4                                            00221
      BWH=DIFT+HE+HF                                                    00222**8
C
C CALCULATE OUTLET VELOCITY (VO).
C
706   D5=AMAX1(TWV,CRITD)                                               00223
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00224**8
      VO=QPP/A                                                          00225
800   BWHEL=BWH+INEL                                                    00226
      IF (KC(64).NE.1) GO TO 801                                        00227
C                                                                       00228
C ESTIMATED COST CALCULATION                                            00229
C                                                                       00230
      CALL IINDEX(J,DIFT,ITYP)                                          00231**8
      CALL PIPCOS(J)                                                    00232
  801 DIAM=DIFT*12.                                                     00233**8
      RETURN                                                            00234
  802 RETURN 1                                                          00235**9
      END                                                               00236
      SUBROUTINE RC41(BWHEL,*)                                          00001*12
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH       00002*12
      INTEGER SHAPE,PROFIL,OPENGS                                       00003**8
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),        00004
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00005**8
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00006
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00007
      COMMON/COSCOM/PRC(90),CONC,STL,FILLH,CMISC,COSFT,TOTCOS           00008
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00009**7
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00010*11
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00011**7
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00012**7
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00013**8
      DIMENSION QT(6),ACO(6)                                            00014
C                                                                       00015
C     THIS ROUTINE ANALYZES A STRAIGHT, CIRCULAR, FLARED,               00016
C     SINGLE-OPENING CULVERT                                            00017
C                                                                       00018
      QPP=QPEAK/BBLS                                                    00019
      LENGTH=ABS(INSTA-OUTSTA)                                          00020
      SLOPE=(INEL-OUTEL)/LENGTH                                         00021
      TW=WATEL-OUTEL                                                    00022
      D=DIFT                                                            00023*11
C                                                                       00024
C ASSIGN N VALUE                                                        00025
C                                                                       00026
      IF (MANN.EQ.1.0) MANN=0.012                                       00027
      IF (MANN.EQ.2.0) MANN=0.024                                       00028
C                                                                       00029
```

```
C ONLY RCP AND CGMP PROCESSED IN THIS ROUTINE
C
      IF (MAT.EQ.1.OR.MAT.EQ.2) GO TO 101
CDEL  WRITE (SYSOUT,1004)
1004  FORMAT (  77H CLB0098--HEADWATER CALCULATION CURVES ARE ONLY VALID
     $ FOR STANDARD REINFORCED  /
     2 10X, 48HCONCRETE PIPE OR STANDARD CORRUGATED METAL PIPE. )
      GO TO 604
 101  QT(1)=QPP/DIFT**2.5
      DO 103 L=2,6
103    QT(L)=QT(L-1)*QT(1)
      IF(QT(1).GE.5.0) GO TO 104
      F=0.0986333+0.145845*QT(1)-0.0130606*QT(2)
      GO TO 200
104   F=0.5
 200  IF (MANN.NE.0.012) GO TO 205
      HWPR=0.216805+0.396390*QT(1)-0.0533907*QT(2)+0.00797812*QT(3)
     1-0.000281416*QT(4)
      GO TO 400
205   BIG1=0.0
      BIG2=0.
      BIG3=0.0
      BIG4=0.0
C
C FOUR CURVES FOR CGMP DEPENDING ON DIAMETER
C
      IF (D.LT.4.0) BIG1=0.342975+0.0277890*QT(1)+0.260673*QT(2)
     1 -0.108629*QT(3)+0.0214553*QT(4)-0.00197451*QT(5)+0.0000697351
     2 *QT(6)
      IF (D.GT.2.0.AND.D.LT.6.0) BIG2=0.351342+0.00107965*QT(1)
     1+0.287643*QT(2)-0.121769*QT(3)+0.0244625*QT(4)-0.00229750*QT(5)
     2 +0.0000828621*QT(6)
      IF (D.GT.4.0.AND.D.LT.8.0) BIG3=0.349196+0.00936189*QT(1)
     1 +0.276799*QT(2)-0.116937*QT(3)+0.0234314*QT(4)-0.00219361*QT(5)
     2 +0.0000788166*QT(6)
      IF (D.GT.6.0) BIG4=0.349380+0.0102961*QT(1)+0.271994*QT(2)
     1 -0.114066*QT(3)+0.0226731*QT(4)-0.00210414*QT(5)+0.0000749226
     2 *QT(6)
C
C INTERPOLATION FOR CGMP
C
      HWPR=(4.-AMAX1(2.,D))/2.*BIG1+(1.-ABS(4.-D)/2.)*BIG2+(1.-ABS(6.-D)
     1 /2.)*BIG3+(AMIN1(8.,D)-6.)/2.*BIG4
 400  CALL CRITIC(QPP,DIFT,CRITD,CRSLPE,MANN)
      IF (SLOPE.LT.CRSLPE) GO TO 405
      IF(TW.LE.SLOPE*LENGTH+DIFT) GO TO 408
      GO TO 402
  405 KECF=0.2
      CALL CULNOR(BWHEL,QPP,CRITD,TW)
      BWH=BWHEL-INEL
      JROUTE=4
      GO TO 416
408   IF (TW.LE.SLOPE*LENGTH) GO TO 407
      IF (MANN.EQ.0.012) GO TO 409
      ACO(1)=0.167433
      ACO(2)=0.538595
      ACO(3)=-0.149374
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      ACO(4)=0.0391543                                                  00087
      ACO(5)=-0.00343974                                                00088
      ACO(6)=0.000115882                                                00089
      GO TO 410                                                         00090
409   ACO(1)=0.114099                                                   00091
      ACO(2)=0.653562                                                   00092
      ACO(3)=-0.233615                                                  00093
      ACO(4)=0.0597723                                                  00094
      ACO(5)=-0.00616338                                                00095
      ACO(6)=0.000242832                                                00096
  410 XENT=QPP/DIFT**2.5                                                00097*11
      HWOD=ACO(1)                                                       00098
      P=1.                                                              00099
      DO 411 J=2,6                                                      00100
      P=P*XENT                                                          00101
411   HWOD=HWOD+ACO(J)*P                                                00102
      BWH=HWOD*DIFT                                                     00103*11
      JROUTE=5                                                          00104
      GO TO 415                                                         00105
  407 BWH=DIFT*(HWPR-F*SLOPE)-SLOPE*1.5*DIFT                            00106*11
      JROUTE=1                                                          00107
      GO TO 415                                                         00108
  402 HW4=QPP**2/100.*(2.5204*(1.+KECF)/DIFT**4+466.153*MANN**2*LENGTH/ 00109*11
     . DIFT**(16./3.))+AMAX1(TW,CRITD)-SLOPE*LENGTH                     00110*11
      HWF=DIFT*(HWPR-F*SLOPE)-SLOPE*1.5*DIFT                            00111*11
      IF(HWF.GT.HW4) GO TO 404                                          00112
      BWH=HW4                                                           00113
      JROUTE=3                                                          00114
      GO TO 415                                                         00115
 404  BWH=HWF                                                           00116
      JROUTE=2                                                          00117
  415 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)              00118*11
      CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,D5,    00119*12
     1 *606)                                                            00120*12
      CALL JUMP(D5,DIFT,QPP,D2,CRITD,MANN)                              00121*11
      IF(D2.GT.TW) GO TO 507                                            00122
      D5=AMIN1(TW,DIFT)                                                 00123*11
  507 CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)                                 00124*11
      VO=QPP/A                                                          00125
 416  GO TO(417,419,421,423,425), JROUTE                                00126
 417  CONTINUE
CDEL  WRITE(SYSOUT,1001)                                                00127
1001  FORMAT (  68H CLB0099--OUTLET CONDITIONS NOT CONSIDERED BECAUSE TW00128**6
     $ INSIGNIFICANT.   )                                               00129**6
      GO TO 604                                                         00130
 419  CONTINUE
CDEL  WRITE (SYSOUT,1002)                                               00131
1002  FORMAT (  64H CLB0100--OUTLET CONDITIONS CONSIDERED BUT FOUND NOT 00132**6
     $TO CONTROL.  )                                                    00133**6
      GO TO 604                                                         00134
 421  CONTINUE
CDEL  WRITE (SYSOUT,1003)                                               00135
1003  FORMAT (  65H CLB0101--OUTLET CONDITIONS CONTROL - FLARED INLET HA00136**6
     $S NO EFFECT. )                                                    00137**6
      D5=AMIN1(TW,DIFT)                                                 00138*11
      CALL CIRCLE(D5,A,S,DIFT,QTEM,MANN)                                00139*11
      VO=QTEM/A                                                         00140
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      GO TO 604                                                         00141
 423  CONTINUE
CDEL  WRITE(SYSOUT,1005)                                                00142
1005  FORMAT (  74H CLB0102--CONVENTIONAL CULVERT ANALYSIS USED.  FLARED00143**6
     $ INLET NOT EFFECTIVE. )                                           00144**6
      GO TO 605                                                         00145**4
 425  CONTINUE
CDEL  WRITE(SYSOUT,1006)                                                00146
1006  FORMAT (  70H CLB0103--HEADWATER BASED ON ENTRANCE CONTROL BUT NOT00147**6
     $ FLARED ENTRANCE.  )                                              00148**6
  604 DIAM=DIFT*12.0                                                    00149*11
      BWHEL=BWH+INEL                                                    00150
  605 RETURN                                                            00151**4
  606 RETURN 1                                                          00152*12
      END                                                               00153
      SUBROUTINE RC43 (BWHEL,*)                                         00001
      DIMENSION ACO(6),RISE(11)                                         00002
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LENGTH,LFTSS       00003
      INTEGER SHAPE,PROFIL,OPENGS                                       00004**4
      COMMON/ARCHP/A1,AK1,AK2,ALPHA,ARC,B,BETA,D1,D3,D5,H1,H2,H3,R1,R2, 00005
     1 R3,W,WPR                                                         00006
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),        00007
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00008**4
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00009
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00010
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00011**3
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00012**8
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00013**3
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00014**3
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00016**4
      DATA RISE/0.938,1.125,1.500,1.875,2.250,2.625,3.000,3.375,3.750,  00017
     1  4.500,5.250/                                                    00018
      SLOP(A,X,Y,D)=A**2*X**2/(2.208*Y**2*D**(4./3.))                   00019
C                                                                       00020
C THIS ROUTINE ANALYZES A STRAIGHT, NORMAL, ARCH, SINGLE-OPENING CULVERT00021
C                                                                       00022
  100 HISAV=HIGH                                                        00023**8
      WISAV=WIDE                                                        00024**8
      DIFF=100.                                                         00025
      NK=0                                                              00026
      ITYP=4                                                            00027
C                                                                       00028
C ESTABLISH N VALUE                                                     00029
C                                                                       00030
      GO TO (101,102,103), MAT                                          00031
      GO TO 104                                                         00032
101   MANN=0.012                                                        00033
      GO TO 104                                                         00034
102   MANN=0.024                                                        00035
      ITYP=5                                                            00036
      IF (HIGH.GT.45.0) MANN=0.027                                      00037
      GO TO 104                                                         00038
103   IF (MANN.EQ.3.0) MANN=0.0371*((HIGH+WIDE)/24.)**(-0.0772)         00039
104   LENGTH=ABS(INSTA-OUTSTA)                                          00040
      SLOPE=(INEL-OUTEL)/LENGTH                                         00041
      TW=WATEL-OUTEL                                                    00042
      QPP=QPEAK/BBLS                                                    00043
```

```
C
C MATCH GIVEN DIMENSION WITH STANDARD
C
      IF (MAT.EQ.3.OR.MANN.EQ.0.027) GO TO 107
      DO 105 N=1,11
      TDIFF=ABS(HIGH-RISE(N)*12.)
      IF (TDIFF.GT.2.0.OR.TDIFF.GT.DIFF) GO TO 105
      DIFF=TDIFF
      NK=N
105   CONTINUE
      IF (NK.NE.0) GO TO 106
CDEL  WRITE (SYSOUT,1003)
1003  FORMAT (  73H CLB0104--NOMINAL DIMENSIONS GIVEN DO NOT AGREE WITH
     $STANDARD DIMENSIONS. )
      GO TO 901
  107 CALL MLTPLT(CRITD,RDUM,IDUM,JDUM,*901)
      GO TO 108
C
C CALCULATE PIPE DIMENSIONS FOR NON MULTI-PLATE SIZES
C
  106 HIFT=RISE(NK)
      WIFT=1.62261*HIFT
      A1=0.63333*HIFT
      B=0.16553*HIFT
      R1=2.33333*HIFT
      R2=0.83333*HIFT
      R3=0.24667*HIFT
      W=WIFT-2*R3
      D1=0.9624586*R3
      H1=0.03754141*R1
      H2=D1
      ALPHA=2.58842
      H3=0.2714286*R3
      D2=H3
      AK1=0.281898
      F2=D1
      AK2=F2/D2
      D3=D1+D2+H1-B
      BETA=1.29592
C
C CALCULATE CRITICAL DEPTH AND CRITICAL SLOPE FOR NON MULTI-PLATE SIZES
C
      FAC=QPP/(WIFT*HIFT**1.5)
      IF (FAC.LE.10.5) GO TO 109
      CRITD=0.99*HIFT
      GO TO 110
109   CRITD=((((((-0.0000058507)*FAC+0.00019451)*FAC-0.0024461)*FAC
     1 +0.015275)*FAC-0.065615)*FAC+0.30225)*FAC+0.11709)*HIFT
110   D5=CRITD
      CALL AREAH
      CALL WETPR
      R=ARC/WPR
      CRSLPE=SLOP(QPP,MANN,ARC,R)
C
C TESTS TO DETERMINE PROPER HEADWATER CALCULATION
C
108   IF (SLOPE.GT.CRSLPE) GO TO 301
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      IF (CRITD.GT.TW) GO TO 800
      IF(TW.LE.HIFT) GO TO 700
302   ADD=TW
      GO TO 600
301   IF (TW.LE.SLOPE*LENGTH) GO TO 400
      IF(TW.GT.SLOPE*LENGTH+HIFT) GO TO 302
C
C KC(24)=4 WHERE TAILWATER MIGHT INFLUENCE HEADWATER ON STEEP SLOPE CULV
C
      KC(24)=4
C
C ENTRANCE CONTROL HEADWATER CALCULATION
C
400   CONTINUE
CDEL  IF (MANN.EQ.0.012) WRITE (SYSOUT,1000)
1000  FORMAT (' INLET CURVES BASED ON CGM MODELS. COMPUTATIONS CONTINUE'
     1)
      IF (KECF.EQ.0.5) GO TO 401
      IF (KECF.EQ.0.7) GO TO 402
      ACO(1)=0.089053
      ACO(2)=0.71254
      ACO(3)=-0.27092
      ACO(4)=0.079250
      ACO(5)=-0.0079805
      ACO(6)=0.00029321
      GO TO 404
402   ACO(1)=0.083301
      ACO(2)=0.79514
      ACO(3)=-0.43408
      ACO(4)=0.16377
      ACO(5)=-0.024914
      ACO(6)=0.0014107
      GO TO 404
401   ACO(1)=0.11128
      ACO(2)=0.61058
      ACO(3)=-0.19494
      ACO(4)=0.051289
      ACO(5)=-0.0048054
      ACO(6)=0.00016855
  404 F=QPP/(WIFT*HIFT**1.5)
      P=1.
      HOD=ACO(1)
      DO 405 J=2,6
       P=P*F
405   HOD=HOD+P*ACO(J)
      BWH=HIFT*HOD
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
      CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,D5,
     1 *901)
      CALL AREAH
      VO=QPP/ARC
      IF (KC(24).NE.4) GO TO 900
      D5=AMIN1(TW,HIFT)
      CALL AREAH
      V3=QPP/ARC
      HW3=BWH
      IF(TW.GE.HIFT) GO TO 501
```

```
      P1=(CRITD+HIFT)/2.
      GO TO 502
501   P1=TW
502   KC(24)=4
      ADD=P1
C
C FULL FLOW - OUTLET CONTROL HEADWATER CALCULATION
C
  600 D5=HIFT
      CALL AREAH
      CALL WETPR
      VO=QPP/ARC
      R=ARC/WPR
      SF=SLOP(QPP,MANN,ARC,R)
      HE=(1.+KECF)*VO**2/64.4
      HF=SF*LENGTH
      BWH=ADD+HE+HF-SLOPE*LENGTH
      IF (KC(24).NE.4) GO TO 900
      D5=AMAX1(TW,HIFT)
      CALL AREAH
      V4=QPP/ARC
      HW4=BWH
      IF (HW3.GT.HW4) GO TO 603
      BWH=HW4
      VO=V4
      GO TO 900
603   BWH=HW3
      VO=V3
      GO TO 900
C
C HEADWATER CALCULATION FOR TAILWATER GREATER THAN CRITICAL DEPTH BUT LE
C HIGH.  (SLOPE LESS THAN CRITICAL SLOPE)
C
  700 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
      IF (TW-UDEP) 801,701,702
701   D5=UDEP
      WDEP=UDEP
      GO TO 703
  702 CALL BWM1(SHAPE,TW,DIFT,WIFT,QPP,MANN,SLOPE,LENGTH,UDEP,WDEP)
      D5=WDEP
703   CALL AREAH
      V=QPP/ARC
      BWH=(1.+KECF)*V**2/64.4+WDEP
      D5=TW
      CALL AREAH
      VO=QPP/ARC
      GO TO 900
C
C HEADWATER CALCULATION FOR TAILWATER LESS THAN CRITICAL DEPTH AND UNIFO
C  (SLOPE LESS THAN CRITICAL SLOPE)
C
  800 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
  801 CALL BWM2(TW,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLOPE,LENGTH,UDEP,
     . WDEP,D5,DIST,HIFT)
      IF (DIST.LT.LENGTH) GO TO 802
      D5=WDEP
804   CALL AREAH
```

```
      V=QPP/ARC
      HE=(1.+KECF)*V**2/64.4
      BWH=WDEP+HE
      GO TO 805
803   D5=UDEP
      GO TO 804
  802 IF(WDEP.LT.0.9257*HIFT) GO TO 803
      D5=HIFT
      CALL AREAH
      CALL WETPR
      R=ARC/WPR
      SF=SLOP(QPP,MANN,ARC,R)
      V=QPP/ARC
      HF=(LENGTH-DIST)*(SF-SLOPE)
      HE=(1.+KECF)*V**2/64.4
      BWH=HIFT+HE+HF
805   UDEP=AMAX1(TW,CRITD)
      D5=UDEP
      CALL AREAH
      VO=QPP/ARC
  900 HIGH=HISAV
      WIDE=WISAV
      HIFT=HIGH/12.
      WIFT=WIDE/12.
      BWHEL=BWH+INEL
      KC(24)=0
      IF (KC(64).NE.1) GO TO 902
C
C COST CALCULATION
C
      HIGHF=HIGHF/12.
      CALL IINDEX(J,HIFT,ITYP)
      CALL PIPCOS(J)
902   RETURN
901   RETURN1
      END
      SUBROUTINE RC47 (BWHEL,*)
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,KECF1,LEN,LENGTH,LFTSS
      INTEGER SHAPE,PROFIL,OPENGS
      COMMON ACRES,CA,FREQ,QPEAK,TC,       ISECN(50,50),ISTA(50),
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
      DIMENSION ACO(6)
      SLOP(A,B,C,D)=A**2*B**2/(2.208*C**2*D**(4./3.))
C
C     THIS ROUTINE ANALYZES A STRAIGHT, NORMAL, SINGLE-OPENING
C     BOX CULVERT
C
100   TW=WATEL-OUTEL
      IF(TW.LT.0.0) TW=0.0
      KECF1=KECF
```

```
      KFLAG=0
      IF(MANN.EQ.1.0) MANN=0.012
      SLOPE=(INEL-OUTEL)/ABS(INSTA-OUTSTA)
      LENGTH=ABS(INSTA-OUTSTA)
      QPP=QPEAK/BBLS
C
C CRITICAL DEPTH AND CRITICAL SLOPE CALCULATION
C
      HIFT=HIGH/12.
      WIFT=WIDE/12.
      CRITD=(((QPP/WIFT)**2)/32.2)**(1./3.)
      IF(CRITD.LT.HIFT) GO TO 108
      ADD=AMAX1(HIFT,TW)
      CALL BOXUD (SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
      IF (UDEP.LT.HIFT) GO TO 200
      GO TO 500
  108 A=CRITD*WIFT
      WP=2.*CRITD+WIFT
      R=A/WP
      CRSLPE=SLOP(QPP,MANN,A,R)
C
C TEST FOR PROPER HEADWATER CALCULATION METHOD
C
      IF (SLOPE.LT.CRSLPE) GO TO 203
200   IF (TW.LE.SLOPE*LENGTH) GO TO 300
      IF(TW.GT.(SLOPE*LENGTH+HIFT)) GO TO 204
      IF (TW.LT.SLOPE*LENGTH+CRITD) GO TO 300
      IF(TW.LT.HIFT) GO TO 205
      KFLAG=4
      GO TO 300
203   IF (CRITD.GT.TW) GO TO 700
      IF(TW.GE.HIFT) GO TO 204
      GO TO 600
204   ADD=TW
      GO TO 500
205   ADD=WATEL-INEL
      VENT=QPP/(ADD*WIFT)
      BWH=ADD+(1.+KECF)*VENT**2/64.4
      GO TO 309
C
C ENTRANCE CONTROL HEADWATER CALCULATION
C
300   IF (KECF.EQ.0.15.OR.KECF.EQ.0.4) GO TO 308
      IF (KECF.EQ.0.5) GO TO 301
      ACO(1)=0.144138
      ACO(2)=0.461363
      ACO(3)=-0.0921507
      ACO(4)=0.0200028
      ACO(5)=-0.00136449
      ACO(6)=0.0000358431
      GO TO 302
301   ACO(1)=0.122117
      ACO(2)=0.505435
      ACO(3)=-0.108560
      ACO(4)=0.0207809
      ACO(5)=-0.00136757
      ACO(6)=0.0000345642
```

```
      GO TO 302                                                         00079
308   ACO(1)=0.0724927                                                  00080
      ACO(2)=0.507087                                                   00081
      ACO(3)=-0.117474                                                  00082
      ACO(4)=0.0221702                                                  00083
      ACO(5)=-0.00148958                                                00084
      ACO(6)=0.0000380126                                               00085
C                                                                       00086
C SOLVE FOR HEADWATER BY FORMULA FOR EMPIRICAL CURVE OF ENTRANCE CONTROL00087
C HEADWATER                                                             00088
C                                                                       00089
  302 XENT=(QPP/WIFT)/HIFT**1.5                                         00090*17
      HWOD=ACO(1)                                                       00091
      P=1.                                                              00092
      DO 303 J=2,6                                                      00093
       P=P*XENT                                                         00094
       HWOD=HWOD+ACO(J)*P                                               00095
303   CONTINUE                                                          00096
      BWH=HWOD*HIFT                                                     00097*17
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)              00098*17
      IF(UDEP.EQ.HIFT) GO TO 306                                        00099*17
C                                                                       00100
C CHECK FOR HYDRAULIC JUMP                                              00101
C                                                                       00102
C  IF CRITD GREATER THAN HIFT, CALL BWS2 W HIFT                         00103*18
C                                                                       00104*18
      CRITKP=CRITD                                                      00105*18
      IF (CRITD.GT.HIFT) CRITD=HIFT                                     00106*18
      CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,D5,    00107*18
     1 *801)                                                            00108*18
      CRITD=CRITKP                                                      00109*18
      A=WIFT*D5                                                         00110*17
      D2=-D5/2.+SQRT(2.*QPP**2/(D5*WIFT)**2*D5/32.2+D5**2/4.)           00111*17
      IF(D2.LT.HIFT) GO TO 305                                          00112*17
      A2=HIFT*WIFT                                                      00113*17
      D2=QPP**2/(32.2*A2)*(1./A-1./A2)+A/A2*D5/2.+0.5*HIFT              00114*17
305   IF (D2.GT.TW) GO TO 307                                           00115
      IF(TW.GT.HIFT) GO TO 306                                          00116*17
  309 A=WIFT*TW                                                         00117*17
      GO TO 304                                                         00118
  306 A=WIFT*HIFT                                                       00119*17
      GO TO 304                                                         00120
  307 A=WIFT*D5                                                         00121*17
304   VO=QPP/A                                                          00122
C                                                                       00123
C KFLAG=4 WHEN HEADWATER MAY BE ENTRANCE OR OUTLET CONTROL              00124
C                                                                       00125
      IF (KFLAG.NE.4) GO TO 800                                         00126
      V3=VO                                                             00127
      HW3=BWH                                                           00128
      IF(TW.GE.HIFT) GO TO 402                                          00129*17
      P1=(CRITD+HIFT)/2.                                                00130*17
      IF(P1.GE.TW)GO TO 403                                             00131
402   P1=TW                                                             00132
403   KFLAG=4                                                           00133
      ADD=P1                                                            00134
      GO TO 500                                                         00135
```

```
404   HW4=BWH
      V4=QPP/A
      IF (HW3.GT.HW4) GO TO 405
      VO=V4
      GO TO 800
405   BWH=HW3
      VO=V3
      GO TO 800
C
C FULL FLOW OUTLET CONTROL HEADWATER
C
  500 A=HIFT*WIFT
      WP=2.*(HIFT+WIFT)
      R=A/WP
      VO=QPP/A
      HE = (1.+KECF1)*VO**2/64.4
      HF=LENGTH*SLOP(QPP,MANN,A,R)
      BWH=ADD+HE+HF-SLOPE*LENGTH
      IF (KFLAG.NE.4) GO TO 800
      IF(TW.GE.HIFT) GO TO 503
      IF (TW.GT.CRITD) GO TO 505
      IF(CRITD.GT.HIFT) GO TO 503
      A=CRITD*WIFT
      GO TO 404
  505 A=TW*WIFT
      GO TO 404
  503 A=HIFT*WIFT
      GO TO 404
C
C HEADWATER CALCULATION FOR TAILWATER GREATER THAN CRITICAL DEPTH BUT LE
C      HIGH.   (SLOPE LESS THAN CRITICAL SLOPE)
C
  600 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
      IF (TW-UDEP) 700,601,602
601   WDEP=UDEP
      GO TO 603
  602 CALL BWM1(SHAPE,TW,DIFT,WIFT,QPP,MANN,SLOPE,LENGTH,UDEP,WDEP)
  603 A=WDEP*WIFT
      V=QPP/A
      BWH=(1.+KECF)*V**2/64.4+WDEP
      VO=QPP/(WIFT*TW)
      GO TO 800
C
C HEADWATER CALCULATION FOR TAILWATER LESS THAN CRITICAL DEPTH AND
C   UNIFORM DEPTH.  (SLOPE LESS THAN CRITICAL SLOPE)
C
  700 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
      CALL BWM2(TW,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLOPE,LENGTH,UDEP,
     . WDEP,D5,DIST,HIFT)
      IF (DIST.LT.LENGTH) GO TO 702
      D4=WDEP
  703 V=QPP/(WIFT*D4)
      HE=(1.+KECF)*V**2/64.4
      BWH=WDEP+HE
      GO TO 707
  702 IF(WDEP.GE.HIFT) GO TO 705
      D4=UDEP
```

```
      GO TO 703                                                         00193
  705 A=WIFT*HIFT                                                       00194*17
      WP=2.*(WIFT+HIFT)                                                 00195*17
      R=A/WP                                                            00196
      V=QPP/A                                                           00197
      HF=(LENGTH-DIST)*(SLOP(QPP,MANN,A,R)-SLOPE)                       00198
      HE=(1.+KECF)*V**2/64.4                                            00199
      BWH=HIFT+HE+HF                                                    00200*17
  707 VO=QPP/(WIFT*AMIN1(HIFT,AMAX1(TW,CRITD)))                         00201*17
800   BWHEL=BWH+INEL                                                    00202
C                                                                       00203
C ESTIMATED COST CALCULATION                                            00204
C                                                                       00205
      IF (KC(64).EQ.1) CALL COST                                        00206
      WIDE=WIFT*12.                                                     00207*17
      HIGH=HIFT*12.                                                     00208*17
      RETURN                                                            00209
  801 RETURN 1                                                          00210*18
      END                                                               00211
      SUBROUTINE RC47FLP (BWHEL,*)                                      00001*18
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,KECF1,LEN,LENGTH,LFTSS 00002
      INTEGER SHAPE,PROFIL,OPENGS                                       00003*14
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),        00004
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00005*14
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00006
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00007*17
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00008
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00009
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00010*14
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00011
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00012
      DIMENSION ACO(6)                                                  00013
      SLOP(A,B,C,D)=A**2*B**2/(2.208*C**2*D**(4./3.))                   00014
C                                                                       00015
C     THIS ROUTINE ANALYZES A STRAIGHT, NORMAL, SINGLE-OPENING          00016
C     BOX CULVERT                                                       00017
C                                                                       00018
100   TW=WATEL-OUTEL                                                    00019
      IF(TW.LT.0.0) TW=0.0                                              00020*10
      KECF1=KECF                                                        00021
      KFLAG=0                                                           00022
      IF(MANN.EQ.1.0) MANN=0.012                                        00023
      SLOPE=(INEL-OUTEL)/ABS(INSTA-OUTSTA)                              00024
      LENGTH=ABS(INSTA-OUTSTA)                                          00025
      QPP=QPEAK/BBLS                                                    00026
C TWV IS THE EFFECTIVE TW ACCOUNTING FOR HEAD LOSS DUE TO A
C DOWNSTREAM VALVE.
C
C THIS FIRST SET OF CALCULATIONS ASSUMES THAT THE FLOW DEPTH AT THE
C DOWNSTREAM END OF THE CULVERT IS CONTROLLED BY THE TAILWATER.  THUS,
C FOR SOME OF THE SUBSEQUENT CALCULATIONS, THE VALUE OF TWV NEEDS TO
C BE RECOMPUTED.

C FOR TW BELOW SOFFIT, GO TO 990.
C
      ICULFLAG=0
 980  IF(TW.LT.HIFT) GOTO 990
```

```
C
C FOR FULL FLOW DUE TO TW SUBMERGENCE, ADD HEAD LOSS DUE TO GATE, AND
C ADJUST TW TO HIGHER EFFECTIVE VALUE.
C
 985  AREA=HIFT*DIFT
      V=QPP/AREA
      XKFLAP=8.*EXP(-1.15*V/SQRT(DIFT))
      TWV=TW+XKFLAP*V**2/64.4
      TWVFULL=TWV
      IF(ICULFLAG.EQ.1)GOTO 203
      GOTO 1010
C
C FOR TW BELOW DOWNSTREAM SOFFITT, DO TRIAL AND ERROR SOLUTION OF
C ENERGY EQUATION TO GET DEPTH (TWV) IN CULVERT JUST UPSTREAM OF GATE
C ASSUMING THAT THE DEPTH AT THE DOWNSTREAM END OF THE CULVERT WOULD
C BE TW IF THERE WERE NO GATE PRESENT.
C
 990  CONTINUE
      RHS=TW
      TWVMAX=HIFT
      TWVMIN=0.
      TWV=0.5*(TWVMAX+TWVMIN)
      DO 1000 ITWV=1,25
      AREA=TWV*WIFT
      V=QPP/AREA
      XKFLAP=8.*EXP(-1.15*V/SQRT(DIFT))
      XKFLAP=0.
      XLHS=TWV-XKFLAP*V**2/64.4
      IF(XLHS.LT.RHS)TWVMIN=TWV
      IF(XLHS.GT.RHS)TWVMAX=TWV
      TWV=0.5*(TWVMAX+TWVMIN)
      IF(ABS(XLHS-RHS).LE.0.01) GOTO 1010
 1000 CONTINUE
C
C CHECK FOR LACK OF CONVERGENCE BECAUSE PIPE IS FULL DUE TO HEAD
C LOSS EVEN THOUGH TW IS BELOW SOFFITT.
C
      IF((HIFT-TWVMIN).LT.0.01) GOTO 985
C
      WRITE(6,1009)
1009  FORMAT(1X,'WARNING 1009: TAILWATER ENERGY DNC. CULVERT FULL.',/,
     &          ' TW BELOW SOFFITT.')
C
C
 1010 CONTINUE
C                                                                       00027
C CRITICAL DEPTH AND CRITICAL SLOPE CALCULATION                         00028
C                                                                       00029
      HIFT=HIGH/12.                                                     00030*17
      WIFT=WIDE/12.                                                     00031*17
      CRITD=(((QPP/WIFT)**2)/32.2)**(1./3.)                             00032*17
      IF(CRITD.LT.HIFT) GO TO 108                                       00033*17
      ADD=AMAX1(HIFT,TWV)                                               00034*18
      CALL BOXUD (SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)             00035*18
      IF (UDEP.LT.HIFT) GO TO 200                                       00036*18
      GO TO 500                                                         00037*10
  108 A=CRITD*WIFT                                                      00038*17
```

```
      WP=2.*CRITD+WIFT
      R=A/WP
      CRSLPE=SLOP(QPP,MANN,A,R)
C
C TEST FOR PROPER HEADWATER CALCULATION METHOD
C
      IF (SLOPE.LT.CRSLPE) GO TO 203
200   IF (TWV.LE.SLOPE*LENGTH) GO TO 300
      IF(TWV.GT.(SLOPE*LENGTH+HIFT)) GO TO 204
      IF (TWV.LT.SLOPE*LENGTH+CRITD) GO TO 300
      IF(TWV.LT.HIFT) GO TO 205
      KFLAG=4
      GO TO 300
C
      ICULFLAG=1
      GOTO 980
203   CONTINUE
C
C PROGRAM BRANCHES TO THIS POINT ONLY FOR MILD SLOPES ONLY.
C IF TW < CRITD, THEN TWV NEEDS TO BE RECALCULATED.
C
      IF (CRITD.LE.TW) GOTO 1110
      RHS=CRITD
      TWVMAX=DIFT
      TWVMIN=CRITD
      TWV=0.5*(TWVMAX+TWVMIN)
      DO 1100 ITWV=1,15
      AREA=TWV*WIFT
      V=QPP/AREA
      XKFLAP=8.*EXP(-1.15*V/SQRT(DIFT))
      XKFLAP=0.
      XLHS=TWV-XKFLAP*V**2/64.4
      IF(XLHS.LT.RHS)TWVMIN=TWV
      IF(XLHS.GT.RHS)TWVMAX=TWV
      TWV=0.5*(TWVMAX+TWVMIN)
      IF(ABS(XLHS-RHS).LE.0.01) GOTO 1110
 1100 CONTINUE
C
C CHECK FOR LACK OF CONVERGENCE BECAUSE PIPE IS FULL DUE TO HEAD
C LOSS EVEN THOUGH TW IS BELOW SOFFITT.
C
      IF((HIFT-TWVMIN).LT.0.001)THEN
        TWV=TWVFULL
        GOTO 1110
      ENDIF
C
      WRITE(*,1109)
      WRITE(6,1109)
1109  FORMAT(1X,'WARNING 1109: TAILWATER ENERGY DNC. CULVERT FULL.',/,
     &          ' TW BELOW SOFFITT.')
C
C
 1110 CONTINUE
C
C
      IF (CRITD.GT.TWV) GO TO 700
      IF(TWV.GE.HIFT) GO TO 204
```

```
      GO TO 600
204   ADD=TWV
      GO TO 500
205   ADD=WATEL-INEL
      VENT=QPP/(ADD*WIFT)
      BWH=ADD+(1.+KECF)*VENT**2/64.4
      GO TO 309
C
C ENTRANCE CONTROL HEADWATER CALCULATION
C
300   IF (KECF.EQ.0.15.OR.KECF.EQ.0.4) GO TO 308
      IF (KECF.EQ.0.5) GO TO 301
      ACO(1)=0.144138
      ACO(2)=0.461363
      ACO(3)=-0.0921507
      ACO(4)=0.0200028
      ACO(5)=-0.00136449
      ACO(6)=0.0000358431
      GO TO 302
301   ACO(1)=0.122117
      ACO(2)=0.505435
      ACO(3)=-0.108560
      ACO(4)=0.0207809
      ACO(5)=-0.00136757
      ACO(6)=0.0000345642
      GO TO 302
308   ACO(1)=0.0724927
      ACO(2)=0.507087
      ACO(3)=-0.117474
      ACO(4)=0.0221702
      ACO(5)=-0.00148958
      ACO(6)=0.0000380126
C
C SOLVE FOR HEADWATER BY FORMULA FOR EMPIRICAL CURVE OF ENTRANCE CONTROL
C HEADWATER
C
  302 XENT=(QPP/WIFT)/HIFT**1.5
      HWOD=ACO(1)
      P=1.
      DO 303 J=2,6
       P=P*XENT
       HWOD=HWOD+ACO(J)*P
303   CONTINUE
      BWH=HWOD*HIFT
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)
      IF(UDEP.EQ.HIFT) GO TO 306
C
C CHECK FOR HYDRAULIC JUMP
C
C  IF CRITD GREATER THAN HIFT, CALL BWS2 W HIFT
C
      CRITKP=CRITD
      IF (CRITD.GT.HIFT) CRITD=HIFT
      CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,CRITD,SLOPE,UDEP,LENGTH,D5,
     1 *801)
      CRITD=CRITKP
      A=WIFT*D5
```

```
      D2=-D5/2.+SQRT(2.*QPP**2/(D5*WIFT)**2*D5/32.2+D5**2/4.)
      IF(D2.LT.HIFT) GO TO 305
      A2=HIFT*WIFT
      D2=QPP**2/(32.2*A2)*(1./A-1./A2)+A/A2*D5/2.+0.5*HIFT
305   IF (D2.GT.TWV) GO TO 307
      IF(TWV.GT.HIFT) GO TO 306
  309 A=WIFT*TWV
      GO TO 304
  306 A=WIFT*HIFT
      GO TO 304
  307 A=WIFT*D5
304   VO=QPP/A
C
C KFLAG=4 WHEN HEADWATER MAY BE ENTRANCE OR OUTLET CONTROL
C
      IF (KFLAG.NE.4) GO TO 800
      V3=VO
      HW3=BWH
      IF(TWV.GE.HIFT) GO TO 402
      P1=(CRITD+HIFT)/2.
      IF(P1.GE.TWV)GO TO 403
402   P1=TWV
403   KFLAG=4
      ADD=P1
      GO TO 500
404   HW4=BWH
      V4=QPP/A
      IF (HW3.GT.HW4) GO TO 405
      VO=V4
      GO TO 800
405   BWH=HW3
      VO=V3
      GO TO 800
C
C FULL FLOW OUTLET CONTROL HEADWATER
C
  500 A=HIFT*WIFT
      WP=2.*(HIFT+WIFT)
      R=A/WP
      VO=QPP/A
      HE = (1.+KECF1)*VO**2/64.4
      HF=LENGTH*SLOP(QPP,MANN,A,R)
      BWH=ADD+HE+HF-SLOPE*LENGTH
      IF (KFLAG.NE.4) GO TO 800
      IF(TWV.GE.HIFT) GO TO 503
      IF (TWV.GT.CRITD) GO TO 505
      IF(CRITD.GT.HIFT) GO TO 503
      A=CRITD*WIFT
      GO TO 404
  505 A=TWV*WIFT
      GO TO 404
  503 A=HIFT*WIFT
      GO TO 404
C
C HEADWATER CALCULATION FOR TAILWATER GREATER THAN CRITICAL DEPTH BUT LE
C      HIGH.   (SLOPE LESS THAN CRITICAL SLOPE)
C
```

```
  600 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)                00168*17
      IF (TWV-UDEP) 700,601,602                                           00169
601   WDEP=UDEP                                                           00170
      GO TO 603                                                           00171
  602 CALL BWM1(SHAPE,TWV,DIFT,WIFT,QPP,MANN,SLOPE,LENGTH,UDEP,WDEP)      00172*17
  603 A=WDEP*WIFT                                                         00173*17
      V=QPP/A                                                             00174
      BWH=(1.+KECF)*V**2/64.4+WDEP                                        00175
      VO=QPP/(WIFT*TWV)                                                   00176*17
      GO TO 800                                                           00177
C                                                                         00178
C HEADWATER CALCULATION FOR TAILWATER LESS THAN CRITICAL DEPTH AND        00179
C   UNIFORM DEPTH.  (SLOPE LESS THAN CRITICAL SLOPE)                      00180
C                                                                         00181
  700 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLOPE,UDEP)                00182*17
      CALL BWM2(TWV,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLOPE,LENGTH,UDEP,     00183*17
     . WDEP,D5,DIST,HIFT)                                                 00184*17
      IF (DIST.LT.LENGTH) GO TO 702                                       00185
      D4=WDEP                                                             00186
  703 V=QPP/(WIFT*D4)                                                     00187*17
      HE=(1.+KECF)*V**2/64.4                                              00188
      BWH=WDEP+HE                                                         00189
      GO TO 707                                                           00190
  702 IF(WDEP.GE.HIFT) GO TO 705                                          00191*17
      D4=UDEP                                                             00192
      GO TO 703                                                           00193
  705 A=WIFT*HIFT                                                         00194*17
      WP=2.*(WIFT+HIFT)                                                   00195*17
      R=A/WP                                                              00196
      V=QPP/A                                                             00197
      HF=(LENGTH-DIST)*(SLOP(QPP,MANN,A,R)-SLOPE)                         00198
      HE=(1.+KECF)*V**2/64.4                                              00199
      BWH=HIFT+HE+HF                                                      00200*17
  707 VO=QPP/(WIFT*AMIN1(HIFT,AMAX1(TWV,CRITD)))                          00201*17
800   BWHEL=BWH+INEL                                                      00202
C                                                                         00203
C ESTIMATED COST CALCULATION                                              00204
C                                                                         00205
      IF (KC(64).EQ.1) CALL COST                                          00206
      WIDE=WIFT*12.                                                       00207*17
      HIGH=HIFT*12.                                                       00208*17
      RETURN                                                              00209
  801 RETURN 1                                                            00210*18
      END                                                                 00211
      SUBROUTINE RC50(BWHEL,*)                                            00001
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH,LENB    00002
      INTEGER SHAPE,PROFIL,OPENGS                                         00003**4
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),          00004
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                        00005**4
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),                00006
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV       00007
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,        00008**3
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00009**8
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),           00010**3
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),           00011**3
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE      00012**4
C                                                                         00013
```

```
C      THIS ROUTINE ANALYZES BROKEN-BACK CIRCULAR CULVERT WITH NORMAL IN00014
C                                                                       00015
      DIMENSION ACO(6),ELB(4),LENB(3),STB(4)                            00016
      KC(33)=1                                                          00017
      KC(54)=0                                                          00018
      TW=WATEL-OUTEL                                                    00019
      LENGTH=0.                                                         00020
      NUNITS=KC(5)+1                                                    00021
      IF(NUNITS.LE.3)GO TO 11                                           00022
CDEL  WRITE(SYSOUT,902)                                                 00023
902   FORMAT (  79H CLB0096--BROKEN BACK ANALYSIS ROUTINE CAN NOT ACCOMO00024**2
     $DATE MORE THAN TWO BREAKS. )                                      00025**2
  903 RETURN 1                                                          00026**9
C                                                                       00027
C ORDERING OF BREAK STATIONS                                            00028
C                                                                       00029
11    ELB(1)=INEL                                                       00030
      STB(1)=INSTA                                                      00031
      ELB(NUNITS+1)=OUTEL                                               00032
      STB(NUNITS+1)=OUTSTA                                              00033
      I=2                                                               00034
      IF(STB(1).GT.STB(NUNITS+1))GO TO 14                               00035
      IF(NUNITS.EQ.2)GO TO 13                                           00036
      IF(BRSTA(1).GT.BRSTA(2))GO TO 15                                  00037
13    ELB(I)=BREL(I-1)                                                  00038
      STB(I)=BRSTA(I-1)                                                 00039
      IF(I.EQ.NUNITS)GO TO 17                                           00040
      I=I+1                                                             00041
      GO TO 13                                                          00042
14    IF(BRSTA(1).GE.BRSTA(2))GO TO 13                                  00043
15    TEMP=BRSTA(1)                                                     00044
      BRSTA(1)=BRSTA(2)                                                 00045
      BRSTA(2)=TEMP                                                     00046
      TEMP=BREL(1)                                                      00047
      BREL(1)=BREL(2)                                                   00048
      BREL(2)=TEMP                                                      00049
      GO TO 13                                                          00050
17    DO 18 I=1,NUNITS                                                  00051
       LENB(I)=ABS(STB(I+1)-STB(I))                                     00052
       SLP(I)=(ELB(I)-ELB(I+1))/LENB(I)                                 00053
      LENGTH=LENGTH+LENB(I)                                             00054
18    CONTINUE                                                          00055
      QPP=QPEAK/BBLS                                                    00056
C                                                                       00057
C CRITICAL DEPTH AND CRITICAL SLOPE DETERMINATION                       00058
C                                                                       00059
      CALL CRITIC (QPP,DIFT,CRITD,CRSLPE,MANN)                          00060**8
      HIFT=DIFT                                                         00061**8
      WIFT=DIFT                                                         00062**8
      HIGH=HIFT*12.                                                     00063**8
      WIDE=DIFT*12.                                                     00064**8
      DO 19 I=1,NUNITS                                                  00065
       IF(SLP(I).LT.CRSLPE)KC(I+50)=1                                   00066
C                                                                       00067
C  KC(I+50)=1 FOR MILD SLOPE AND 0 FOR STEEP SLOPE                      00068
C                                                                       00069
19    CONTINUE                                                          00070
```

```
      IF(KC(51).EQ.1)GO TO 20
C
C BEGIN ANALYSIS OF FIRST UNIT
C
      DSTAR=CRITD
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(1),UDEP)
      CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,DSTAR,SLP(1),UDEP,LENB(1),
     1 DLAST,*903)
      GO TO 22
20    DLAST=CRITD
22    DSTAR=DLAST
      IF(KC(52).EQ.1)GO TO 30
C
C BEGIN ANALYSIS OF SECOND UNIT
C
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(2),UDEP)
      IF(SLP(1).LE.SLP(2).AND.DSTAR.GE.UDEP)GO TO 24
      CALL BWS3(SHAPE,QPP,MANN,WIFT,SLP(2),DSTAR,LENB(2),HIFT,DIFT,
     1 DLAST)
      GO TO 26
  24  CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,DSTAR,SLP(2),UDEP,LENB(2),
     1 DLAST,*903)
26    IF(NUNITS.EQ.2)GO TO 60
      GO TO 36
30    IF(KC(51).EQ.0)GO TO 32
      DLAST=CRITD
      IF(NUNITS.EQ.2)GO TO 70
      GO TO 36
32    K=2
      CALL BWM3(SHAPE,QPP,MANN,WIFT,CRITD,SLP(2),DSTAR,LENB(2),WATEL,
     . OUTEL,HIFT,K,NUNITS,DLAST)
      IF(NUNITS.EQ.2)GO TO 64
36    DSTAR=DLAST
      IF(KC(53).EQ.1)GO TO 40
C
C BEGIN ANALYSIS OF THIRD UNIT
C
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(3),UDEP)
      IF(SLP(2).LE.SLP(3).AND.DSTAR.GE.UDEP)GO TO 38
      CALL BWS3(SHAPE,QPP,MANN,WIFT,SLP(3),DSTAR,LENB(3),HIFT,DIFT,
     1 DLAST)
      GO TO 60
  38  CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,DSTAR,SLP(3),UDEP,LENB(3),
     1 DLAST,*903)
      GO TO 60
40    IF(KC(52).EQ.0)GO TO 46
      IF(KC(51).EQ.0)GO TO 42
      DLAST=CRITD
      GO TO 70
42    IF(DLAST.EQ.CRITD)GO TO 70
46    K=3
      CALL BWM3(SHAPE,QPP,MANN,WIFT,CRITD,SLP(3),DSTAR,LENB(3),WATEL,
     . OUTEL,HIFT,K,NUNITS,DLAST)
      GO TO 64
60    D5=DLAST
      CALL JUMP(D5,DIFT,QPP,D2,CRITD,MANN)
      IF(D2.LE.TW) GO TO 71
```

```
C
C BEGIN OUTLET VELOCITY CALCULATION
C
64    DOUT=DLAST
      GO TO 80
70    IF(TW.GT.CRITD)GO TO 72
      DOUT=CRITD
      GO TO 80
71    KC(54)=1
  72  IF(TW.GT.HIFT) GO TO 74
      DOUT=TW
      GO TO 80
  74  DOUT=HIFT
80    D5=DOUT
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)
      VOUT=QPP/A
      TWKEEP=TW
C
C HEADWATER CALCULATION
C
      IF(WATEL.GT.INEL+HIFT) GO TO 114
      IF(KC(51).EQ.0)GO TO 100
      IF(KC(52).NE.0)GO TO 120
      K=1
      IF(WATEL.GT.ELB(2)+CRITD)GO TO 114
      DUM = 0.0
C
C HEADWATER CALCULATION FOR MILD SLOPE, FIRST UNIT
C
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(1),UDEP)
      CALL BWM2(DUM,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLP(1),LENB(1),UDEP,
     . WDEP,D5,DIST,HIFT)
      IF (WDEP.EQ.HIFT) GO TO 82
      HF=0.
      D5=WDEP
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)
      GO TO 84
  82  D5=DIFT
      CALL CIRCLE(D5,A,SF,DIFT,QPP,MANN)
      HF=(SF-SLP(1))*(LENB(1)-DIST)
84    V=QPP/A
      HV=V*V/64.4
      HE=KECF*HV
      HW=WDEP+HF+HV+HE
86    TW=TWKEEP
      BWHEL=INEL+HW
      BWH=HW
      VO=VOUT
      DO 98 IK=1,NUNITS
       ISTN1=STB(IK)
       ISTN2=STB(IK+1)
       ILEN=LENB(IK)
CDEL   WRITE(SYSOUT,202)IK,SLP(IK),ILEN,ISTN1,ELB(IK),ISTN2,ELB(IK+1)
202    FORMAT(10X,I2,F11.5,I9,I11,F8.2,I12,F8.2)
98    CONTINUE
      HIFT=0.
      WIFT=0.
```

```
      HIGH=0.
      WIDE=0.
      IF (KC(64).NE.1) GO TO 96
      ITYP=MAT
C
C COST COMPUTATION
C
      CALL IINDEX(J,DIFT,ITYP)
      CALL PIPCOS(J)
   96 DIAM=DIFT*12.
      DO 97 I=1,5
       IF (I.NE.4) KC(I+50)=0
97    CONTINUE
      RETURN
C
C HEADWATER CALCULATION - ENTRANCE CONTROL
C
100   IF(WATEL.GE.INEL+CRITD)KC(55)=1
      IF (MANN.EQ.0.012) GO TO 101
      IF (KECF.EQ.0.2) KECF=0.5
      IF (KECF.EQ.0.7) GO TO 107
      IF (KECF.EQ.0.9) GO TO 108
C
C COEFFICIENTS FOR CGMP
C
      ACO(1)=0.167433
      ACO(2)=0.538595
      ACO(3)=-0.149374
      ACO(4)=0.0391543
      ACO(5)=-0.00343974
      ACO(6)=0.000115882
      GO TO 105
107   ACO(1)=0.107137
      ACO(2)=0.757789
      ACO(3)=-0.361462
      ACO(4)=0.123393
      ACO(5)=-0.0160642
      ACO(6)=0.000767390
      GO TO 105
108   ACO(1)=0.187321
      ACO(2)=0.567710
      ACO(3)=-0.156544
      ACO(4)=0.0447052
      ACO(5)=-0.00343602
      ACO(6)=0.000089661
      GO TO 105
101   IF (KECF.EQ.0.2) GO TO 102
      IF (KECF.EQ.0.25) GO TO 103
      IF (KECF.EQ.0.55) GO TO 104
C
C COEFFICIENTS FOR RCP
C
      ACO(1)=0.087483
      ACO(2)=0.706578
      ACO(3)=-0.253295
      ACO(4)=0.0667001
      ACO(5)=-0.00661651
```

```
      ACO(6)=0.000250619
      GO TO 105
104   ACO(1)=0.167287
      ACO(2)=0.558766
      ACO(3)=-0.159813
      ACO(4)=0.0420069
      ACO(5)=-0.00369252
      ACO(6)=0.000125169
      GO TO 105
103   ACO(1)=0.108786
      ACO(2)=0.662381
      ACO(3)=-0.233801
      ACO(4)=0.0579585
      ACO(5)=-0.00557890
      ACO(6)=0.000205052
      GO TO 105
102   ACO(1)=0.114099
      ACO(2)=0.653562
      ACO(3)=-0.233615
      ACO(4)=0.0597723
      ACO(5)=-0.00616338
      ACO(6)=0.000242832
  105 XENT=QPP/DIFT**2.5
      HWOD=ACO(1)
      P=1.
      DO 106 J=2,6
       P=P*XENT
       HWOD=HWOD+ACO(J)*P
106   CONTINUE
      IF(KC(55).EQ.1)GO TO 112
      HW=HWOD*HIFT
      GO TO 86
  112 HW3=HWOD*HIFT
C
C HEADWATER CALCULATION - FULL FLOW, OUTLET CONTROL
C
  114 D5=DIFT
      CALL CIRCLE(D5,A,SF,DIFT,QPP,MANN)
      TOTL=ABS(INSTA-OUTSTA)
      HF=SF*TOTL
      V=QPP/A
      HV=V*V/64.4
      HE=KECF*HV
      HW=TW+HF+HV+HE-(INEL-OUTEL)
      IF(KC(55).NE.1)GO TO 86
      IF(HW.LE.HW3)HW=HW3
      GO TO 86
120   IF(NUNITS.NE.3)GO TO 122
      IF(KC(53).NE.0)GO TO 124
C
C HEADWATER CALCULATION - PARTIAL FULL FLOW
C
122   K=2
      GO TO 125
124   K=3
  125 IF(WATEL.LE.HIFT+ELB(K+1)) GO TO 126
      IF (K.EQ.1) GO TO 114
```

```
      K=K-1
      GO TO 125
  126 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(K),UDEP)
      TOTL=0.
      IF (WATEL.LE.CRITD+ELB(K+1)) GO TO 130
128   IF (WATEL.LE.UDEP+ELB(K+1)) GO TO 130
      CALL BWM1(SHAPE,TW,DIFT,WIFT,QPP,MANN,SLP(K),LENB(K),UDEP,WDEP)
      GO TO 140
  130 CALL BWM2(TW,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLP(K),LENB(K),UDEP,
     . WDEP,D5,DIST,HIFT)
      IF(WDEP.NE.HIFT) GO TO 140
      GO TO(136,134,132),K
132   TOTL=LENB(K-2)
134   TOTL=TOTL+LENB(K-1)
136   TOTL=TOTL+LENB(K)-DIST
      D5=DIFT
      CALL CIRCLE(D5,A,SF,DIFT,QPP,MANN)
      GO TO(137,138,138),K
137   REDUC=TOTL*SLP(1)
      GO TO 139
138   REDUC=ELB(1)-ELB(K)+(LENB(K)-DIST)*SLP(K)
139   HF=TOTL*SF-REDUC
      GO TO 150
140   TW=WDEP
      GO TO(148,144,142),K
142   K=2
      GO TO 146
144   K=1
  146 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(K),UDEP)
      GO TO 128
148   D5=WDEP
      CALL CIRCLE(D5,A,S,DIFT,QPP,MANN)
      HF=0.
150   V=QPP/A
      HV=V*V/64.4
      HE=KECF*HV
      HW=WDEP+HF+HV+HE
      GO TO 86
      END
      SUBROUTINE RC57(BWHEL,*)
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH,LENB
      INTEGER SHAPE,PROFIL,OPENGS
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE
      DIMENSION ACO(6),ELB(4),LENB(3),STB(4)
      SLOP(AX,BX,CX,DX)=AX*AX*BX*BX/(2.208*CX*CX*DX**1.333333)
C
C      THIS ROUTINE ANALYZES BROKEN-BACK BOX CULVERT WITH NORMAL INLET
C
      KC(33)=1
```

```
      KC(54)=0
      TW=WATEL-OUTEL
      LENGTH=0.
      NUNITS=KC(5)+1
      IF(NUNITS.LE.3)GO TO 11
CDEL  WRITE(SYSOUT,902)
902   FORMAT (  79H CLB0096--BROKEN BACK ANALYSIS ROUTINE CAN NOT ACCOMO
     $DATE MORE THAN TWO BREAKS.  )
  903 RETURN 1
C
C ORDERING OF BREAK STATIONS
C
11    ELB(1)=INEL
      STB(1)=INSTA
      ELB(NUNITS+1)=OUTEL
      STB(NUNITS+1)=OUTSTA
      I=2
      IF(STB(1).GT.STB(NUNITS+1))GO TO 14
      IF(NUNITS.EQ.2)GO TO 13
      IF(BRSTA(1).GT.BRSTA(2))GO TO 15
13    ELB(I)=BREL(I-1)
      STB(I)=BRSTA(I-1)
      IF(I.EQ.NUNITS)GO TO 17
      I=I+1
      GO TO 13
14    IF(BRSTA(1).GE.BRSTA(2))GO TO 13
15    TEMP=BRSTA(1)
      BRSTA(1)=BRSTA(2)
      BRSTA(2)=TEMP
      TEMP=BREL(1)
      BREL(1)=BREL(2)
      BREL(2)=TEMP
      GO TO 13
   17 QPP=QPEAK/BBLS
      QPFT=QPP/WIFT
      CRITD=(QPFT*QPFT/32.2)**.3333333
      DO 27 I=1,NUNITS
      LENB(I)=ABS(STB(I+1)-STB(I))
      LENGTH=LENGTH+LENB(I)
      SLP(I)=(ELB(I)-ELB(I+1))/LENB(I)
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(I),UDEP)
      DC=CRITD
      IF(CRITD.GT.HIFT) GO TO 23
      IF(UDEP.GT.CRITD) GO TO 25
   21 KC(50+I)=0
      GO TO 27
   23 DC=HIFT
      IF(UDEP.GE.HIFT) GO TO 25
      GO TO 21
   25 KC(50+I)=1
   27 CONTINUE
      IF(KC(51).EQ.1)GO TO 20
C
C BEGIN ANALYSIS OF FIRST UNIT
C
      DSTAR=DC
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(1),UDEP)
```

```
      CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,DSTAR,SLP(1),UDEP,LENB(1),
     1 DLAST,*903)
      GO TO 22
20    DLAST=DC
22    DSTAR=DLAST
      IF(KC(52).EQ.1)GO TO 30
C
C BEGIN ANALYSIS OF SECOND UNIT
C
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(2),UDEP)
      IF (SLP(1).LE.SLP(2).AND.DSTAR.GE.UDEP) GO TO 24
      CALL BWS3(SHAPE,QPP,MANN,WIFT,SLP(2),DSTAR,LENB(2),HIFT,DIFT,
     1 DLAST)
      GO TO 26
  24  CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,DSTAR,SLP(2),UDEP,LENB(2),
     1 DLAST,*903)
26    IF(NUNITS.EQ.2)GO TO 60
      GO TO 36
30    IF(KC(51).EQ.0)GO TO 32
      DLAST=DC
      IF(NUNITS.EQ.2)GO TO 70
      GO TO 36
32    K=2
      CALL BWM3(SHAPE,QPP,MANN,WIFT,DC,SLP(2),DSTAR,LENB(2),WATEL,
     . OUTEL,HIFT,K,NUNITS,DLAST)
      IF(NUNITS.EQ.2)GO TO 64
36    DSTAR=DLAST
      IF(KC(53).EQ.1)GO TO 40
C
C BEGIN ANALYSIS OF THIRD UNIT
C
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(3),UDEP)
      IF (SLP(2).LE.SLP(3).AND.DSTAR.GE.UDEP) GO TO 38
      CALL BWS3(SHAPE,QPP,MANN,WIFT,SLP(3),DSTAR,LENB(3),HIFT,DIFT,
     1 DLAST)
      GO TO 60
  38  CALL BWS2(SHAPE,DIFT,QPP,MANN,WIFT,DSTAR,SLP(3),UDEP,LENB(3),
     1 DLAST,*903)
      GO TO 60
40    IF(KC(52).EQ.0)GO TO 46
      IF(KC(51).EQ.0)GO TO 42
      DLAST=DC
      GO TO 70
42    IF(DLAST.EQ.DC)GO TO 70
46    K=3
      CALL BWM3(SHAPE,QPP,MANN,WIFT,DC,SLP(3),DSTAR,LENB(3),WATEL,
     . OUTEL,HIFT,K,NUNITS,DLAST)
      GO TO 64
   60 A1=DLAST*WIFT
      D2=-DLAST/2.+SQRT(2.*QPP*QPP*DLAST/(32.2*A1*A1)+DLAST*DLAST/4.)
      IF(D2.LE.HIFT) GO TO 62
      A2=HIFT*WIFT
      D2=(QPP*QPP/32.2*(1./A1-1./A2)+A1*DLAST/2.)/A2+HIFT/2.
62    IF(D2.LE.TW)GO TO 71
C
C BEGIN OUTLET VELOCITY CALCULATION
C
```

```
64    DOUT=DLAST
      GO TO 80
70    IF(TW.GT.DC)GO TO 72
      DOUT=DC
      GO TO 80
71    KC(54)=1
  72  IF(TW.GT.HIFT) GO TO 74
      DOUT=TW
      GO TO 80
  74  DOUT=HIFT
  80  VOUT=QPP/(DOUT*WIFT)
      TWKEEP=TW
C
C HEADWATER CALCULATION
C
      IF(WATEL.GT.INEL+HIFT) GO TO 114
      IF(KC(51).EQ.0)GO TO 100
      IF(KC(52).NE.0)GO TO 120
      K=1
C
C HEADWATER CALCULATION FOR MILD SLOPE, FIRST UNIT
C
      IF(WATEL.GT.ELB(2)+CRITD)GO TO 114
      CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(1),UDEP)
      CALL BWM2(TW,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLP(1),LENB(1),UDEP,
     . WDEP,D5,DIST,HIFT)
      IF(WDEP.EQ.HIFT) GO TO 82
      HF=0.
      A=WDEP*WIFT
      GO TO 84
  82  A=HIFT*WIFT
      WP=WIFT*2.+2.*HIFT
      R=A/WP
      SF=SLOP(QPP,MANN,A,R)
      HF=(SF-SLP(1))*(LENB(1)-DIST)
84    V=QPP/A
      HV=V*V/64.4
      HE=KECF*HV
      HW=WDEP+HF+HV+HE
86    TW=TWKEEP
      BWHEL=INEL+HW
      BWH=HW
      VO=VOUT
      IF(KC(28).EQ.1) GO TO 99
      DO 98 IK=1,NUNITS
       ISTN1=STB(IK)
       ISTN2=STB(IK+1)
       ILEN=LENB(IK)
CDEL   WRITE(SYSOUT,202)IK,SLP(IK),ILEN,ISTN1,ELB(IK),ISTN2,ELB(IK+1)
202    FORMAT(10X,I2,F11.5,I9,I11,F8.2,I12,F8.2)
98    CONTINUE
99    DO 97 I=1,5
       IF (I.NE.4) KC(I+50)=0
97    CONTINUE
C
C COST COMPUTATION
C
```

```
      IF (KC(64).EQ.1) CALL COST
      RETURN
C
C HEADWATER CALCULATION - ENTRANCE CONTROL
C
100   IF(WATEL.GE.INEL+CRITD)KC(55)=1
      IF (KECF.EQ.0.15.OR.KECF.EQ.0.4) GO TO 104
      IF(KECF.EQ.0.5)GO TO 102
      ACO(1)=0.144138
      ACO(2)=0.461363
      ACO(3)=-0.0921507
      ACO(4)=0.0200028
      ACO(5)=-0.00136449
      ACO(6)=0.0000358431
      GO TO 106
102   ACO(1)=0.122117
      ACO(2)=0.505435
      ACO(3)=-0.108560
      ACO(4)=0.0207809
      ACO(5)=-0.00136757
      ACO(6)=0.0000345642
      GO TO 106
104   ACO(1)=0.0724927
      ACO(2)=0.507087
      ACO(3)=-0.117474
      ACO(4)=0.0221702
      ACO(5)=-0.00148958
      ACO(6)=0.0000380126
  106 XENT=(QPP/WIFT)/HIFT**1.5
      HWOD=ACO(1)
      P=1.
      DO 110 IK=2,6
       P=P*XENT
110   HWOD=HWOD+ACO(IK)*P
      IF(KC(55).EQ.1)GO TO 112
      HW=HWOD*HIFT
      GO TO 86
  112 HW3=HWOD*HIFT
C
C HEADWATER CALCULATION - FULL FLOW, OUTLET CONTROL
C
  114 A=WIFT*HIFT
      WP=2.*(WIFT+HIFT)
      R=A/WP
      TOTL=ABS(INSTA-OUTSTA)
      SF=SLOP(QPP,MANN,A,R)
      HF=SF*TOTL
      V=QPP/A
      HV=V*V/64.4
      HE=KECF*HV
      HW=TW+HF+HV+HE-(INEL-OUTEL)
      IF(KC(55).NE.1)GO TO 86
      IF(HW.LE.HW3)HW=HW3
      GO TO 86
120   IF(NUNITS.NE.3)GO TO 122
      IF(KC(53).NE.0)GO TO 124
C
```

```
C HEADWATER CALCULATION - PARTIAL FULL FLOW                                00247
C                                                                          00248
122   K=2                                                                  00249
      GO TO 125                                                            00250
124   K=3                                                                  00251
  125 IF(WATEL.LE.HIFT+ELB(K+1)) GO TO 126                                 00252**8
       IF (K.EQ.1) GO TO 114                                               00253
       K=K-1                                                               00254
      GO TO 125                                                            00255
  126 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(K),UDEP)                00256**8
      TOTL=0.                                                              00257
      IF (WATEL.LE.CRITD+ELB(K+1)) GO TO 130                               00258
128   IF (WATEL.LE.UDEP+ELB(K+1)) GO TO 130                                00259
      CALL BWM1(SHAPE,TW,DIFT,WIFT,QPP,MANN,SLP(K),LENB(K),UDEP,WDEP)      00260**8
      GO TO 140                                                            00261
  130 CALL BWM2(TW,CRITD,SHAPE,DIFT,QPP,MANN,WIFT,SLP(K),LENB(K),UDEP,     00262**8
     . WDEP,D5,DIST,HIFT)                                                  00263**8
      IF(WDEP.NE.HIFT) GO TO 140                                           00264**8
      GO TO(136,134,132),K                                                 00265
132   TOTL=LENB(K-2)                                                       00266
134   TOTL=TOTL+LENB(K-1)                                                  00267
136   TOTL=TOTL+LENB(K)-DIST                                               00268
      A=HIFT*WIFT                                                          00269**8
      WP=2.*(HIFT+WIFT)                                                    00270**8
      R=A/WP                                                               00271
      SF=SLOP(QPP,MANN,A,R)                                                00272
      GO TO(137,138,138),K                                                 00273
137   REDUC=TOTL*SLP(1)                                                    00274
      GO TO 139                                                            00275
138   REDUC=ELB(1)-ELB(K)+(LENB(K)-DIST)*SLP(K)                            00276
139   HF=TOTL*SF-REDUC                                                     00277
      GO TO 150                                                            00278
140   TW=WDEP                                                              00279
      GO TO(148,144,142),K                                                 00280
142   K=2                                                                  00281
      GO TO 146                                                            00282
144   K=1                                                                  00283
  146 CALL BOXUD(SHAPE,DIFT,HIFT,WIFT,MANN,QPP,SLP(K),UDEP)                00284**8
      GO TO 128                                                            00285
  148 A=WDEP*WIFT                                                          00286**8
      HF=0.                                                                00287
150   V=QPP/A                                                              00288
      HV=V*V/64.4                                                          00289
      HE=KECF*HV                                                           00290
      HW=WDEP+HF+HV+HE                                                     00291
      GO TO 86                                                             00292
      END                                                                  00293
      SUBROUTINE RC6 (X,Y,J)                                               00001
      DIMENSION XT(120),YT(120),X(100),Y(100),NA(10),NP(10),               00002*11
     1 A(10),XSTAR(10),XEND(10),AREA(10)                                   00003*11
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,                00004*16
     1   LENGTH,KNAT,KBRT                                                  00005
      INTEGER SHAPE,PROFIL,OPENGS                                          00006*10
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),           00007
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                         00008*10
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),                 00009
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV        00010
```

```
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00011**8
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00012*15
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00013**8
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00014**8
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00016*10
      COMMON/CCOM1/BRSUB(10),CLVTID,FLSEC,NAME,ORIGID,ROADID            00017*10
      CHARACTER*3 CLVTID,BRSUB,NAME,ROADID                              00018*10
      CHARACTER*4 FLSEC,ORIGID                                          00019*16
100   NA(1)=1                                                           00020
      KBRT=0.                                                           00021
      KNAT=0.                                                           00022
      SUMA=0.                                                           00023
      KC(23)=1                                                          00024
      KC(32)=0.                                                         00025
      NOP=KC(7)                                                         00026
C                                                                       00027
C RECONSTRUCT THE CROSS-SECTION FOR EACH FLOW-DIVIDE SHOWING FROMX AND T00028
C  AS THE BEGINNING AND END POINTS                                      00029
C                                                                       00030
      DO 101 N=1,NOP                                                    00031
      IF (N.NE.1) NA(N)=NA(N-1)+NP(N-1)                                 00032
      II=1                                                              00033
      IFLG=0                                                            00034
      I=1                                                               00035
109   IF (FROMX(N)-X(I)) 104,103,102                                    00036
  103 NSUB = NA(N) + II - 1                                             00037*11
      XT(NSUB) = X(I)                                                   00038*11
      YT(NSUB) = Y(I)                                                   00039*11
      II=II+1                                                           00040
102   I=I+1                                                             00041
      IF (I.GT.NTOTPT(J)) GO TO 108                                     00042
      GO TO 109                                                         00043
104   IF (TOX(N).GT.X(I)) GO TO 105                                     00044
      IF (II.NE.1) GO TO 107                                            00045
      XK=FROMX(N)                                                       00046
      IFLG=0                                                            00047
  106 NSUB = NA(N) + II - 1                                             00048*11
      XT(NSUB) = XK                                                     00049*11
      YT(NSUB) = (X(I) - XK)*(Y(I)-Y(I-1))/(X(I) - X(I-1)) + Y(I)       00050*11
      II=II+1                                                           00051
      GO TO (108,103), IFLG                                             00052
107   XK=TOX(N)                                                         00053
      IFLG=1                                                            00054
      GO TO 106                                                         00055
105   IF (II.NE.1) GO TO 103                                            00056
      XK=FROMX(N)                                                       00057
      IFLG=2                                                            00058
      GO TO 106                                                         00059
108   NP(N)=II-1                                                        00060
101   CONTINUE                                                          00061
C                                                                       00062
C COMPUTE THE AREA FOR EACH FLOW DIVIDE AND THE TOTAL CONVEYANCE        00063
C                                                                       00064
      DO 201 N=1,NOP                                                    00065*16
      CALL CNVYCU(XT(NA(N)),YT(NA(N)),NP(N),CON,ARE,N,J)                00066*11
      AREA(N)=ARE                                                       00067
      CONV(N)=CON                                                       00068
```

```
      KNAT=KNAT+CONV(N)
201   SUMA=SUMA+ARE
      VOLD=1000.
      NKP=0
C
C CALCULATE THE PER CENT OF FLOW FOR EACH FLOW-DIVIDE AND THE MAXIMUM
C PER CENT OF AREA NEEDED TO HANDLE THE MAXIMUM VELOCITY
C
      DO 202 N=1,NOP
      FLOW(N)=CONV(N)/KNAT*QPEAK
      PFLOW(N)=FLOW(N)/QPEAK
      VELOC(N)=FLOW(N)/AREA(N)
      VNEW=VMAXB(N)-VELOC(N)
      IF (VNEW.GE.0.0) GO TO 206
      A(N)=FLOW(N)/VMAXB(N)
      GO TO 405
206   IF (VNEW.GE.VOLD) GO TO 202
      PAREA=(FLOW(N)/VMAXB(N))/AREA(N)
      VOLD=VNEW
      NKP=N
202   CONTINUE
C
C COMPUTE THE AREA NEEDED AT EACH OPENING
C
      DO 205 N=1,NOP
205   A(N)=PAREA*AREA(N)
203   KADJ=0
      KBRT=0.
C
C SIZE A BRIDGE TO EACH FLOW-DIVIDE AND CALCULATE ITS CONVEYANCE
C
      DO 204 N=1,NOP
      IF (A(N).GE.AREA(N)) GO TO 405
      CONV(N)=0.0
      XSTAR(N) = XT(NA(N))
      XEND(N)=XSTAR(N)
      IF (A(N).LT..00001) GO TO 204
      CALL RC4B (XT(NA(N)),YT(NA(N)),NP(N),IDUM,A(N),KK,LL,EXX,EXY,
     1 N,XSTAR(N),XEND(N))
C
C  IF AN ISLAND IS ENCOUNTERED WITHIN A FLOW DIVIDE KC(11) = 1
C
      IF(KC(11).EQ.1)RETURN
      I=KK
      IF (KC(32).EQ.1) I=I+LL
      NSUB = NA(N) + I - 1
      TEMPX = XT(NSUB)
      TEMPY = YT(NSUB)
      YT(NSUB) = EXY
      XT(NSUB) = EXX
      LL=LL+1
      NSUB = NA(N) + KK - 1
      CALL CNVYCU(XT(NSUB),YT(NSUB),LL,CON,ARE,N,J)
      CONV(N)=CON
      NSUB = NA(N) + I -1
      XT(NSUB) = TEMPX
      YT(NSUB) = TEMPY
```

```
      KBRT=KBRT+CONV(N)
204   CONTINUE
C
C COMPUTE THE PER CENT CONVEYANCE AT EACH OPENING AND COMPARE IT TO THE
C CENT FLOW.  RECALCULATE THE AREA NEEDED IF THE 2 PER CENTS ARE NOT
C ABOUT THE SAME.
C
      DO 301 N=1,NOP
      PC(N)=CONV(N)/KBRT
      IF (PC(N).LT..00001.AND.PFLOW(N).LT..00001) GO TO 301
      IF (ABS(PC(N)/PFLOW(N)-1.).LT.0.05) GO TO 301
      IF (N.EQ.NKP) GO TO 301
      A(N)=PFLOW(N)/PC(N)*A(N)
      KADJ=KADJ+1
301   CONTINUE
      IF (KADJ.GT.0) GO TO 203
      VDIF=1000.
      NEAT=0
C
C COMPUTE EACH OPENINGS VELOCITY
C
      DO 302 N=1,NOP
      VELOC(N)=0.0
      IF (A(N).LT..00001) NEAT=N
      IF (A(N).LT..00001) GO TO 302
       VELOC(N)=FLOW(N)/A(N)
       IF (VMAXB(N)-VELOC(N).GE.VDIF) GO TO 302
       VDIF=VMAXB(N)-VELOC(N)
       VOV=VDIF/VMAXB(N)
       NKP=N
302   CONTINUE
C
C CHECK THAT NO VELOCITY EXCEEDS ITS MAXIMUM AND AT LEAST ONE IS
C VERY NEAR ITS MAXIMUM
C
      IF (VDIF.GE.-0.01.AND.VDIF.LT.0.10) GO TO 400
      IF (NEAT.GT.0) GO TO 400
C
C RECOMPUTE THE AREA NEEDED IF NECESSARY
C
      DO 303 N=1,NOP
303   IF (N.EQ.NKP) A(N)=A(N)-A(N)*VOV
      GO TO 203
C
C AT THIS POINT A SATISFACTORY SOLUTION HAS BEEN FOUND
C
400   TOTA=0.
      VAVE1=QPEAK/SUMA
      BWTOT=0.
C
C COMPUTE THE BACKWATER HEAD AND RELATED ELEVATION
C
      DO 401 N=1,NOP
      TOTA=TOTA+A(N)
401   BWTOT=BWTOT+(VELOC(N)**2-VAVE1**2)/64.4
      BW1=BWTOT/NOP
      VAVE2=QPEAK/TOTA
```

```
      BW2=(VAVE2**2-VAVE1**2)/64.4                                      00183
      BWH=AMAX1(BW1,BW2)                                                00184
C                                                                       00185
C CALL ROUTINE TO PRINT THE REPORT                                      00186
C                                                                       00187
CDEL  CALL BRRPT (XSTAR,XEND,J)                                         00188*16
      IF(KC(27).EQ.0) RETURN                                            00189
      DO 403 N=1,NOP                                                    00190
       FROMX(N)=XSTAR(N)                                                00191
       TOX(N)=XEND(N)                                                   00192
  403 CONTINUE                                                          00193
407   RETURN                                                            00194
  405 CONTINUE
CDEL  CALL PAGE                                                         00195*12
CDEL  WRITE (SYSOUT,1000)                                               00196
1000  FORMAT (  79H CLB0094--*** AREA NEEDED TO SATISFY MAX VELOCITY IS 00197**7
     $GREATER THAN TOTAL AREA OF   /                                    00198**7
     2   10X,              12HFLOW-DIVIDE. )                            00199**7
CDEL  WRITE (SYSOUT, 1003)                                              00200**7
1003  FORMAT (   10X, 41H***  SUGGEST CHANGING FLOW-DIVIDE LIMITS.  //  00201**7
     $ 10X,  5HFL-DV, 10X,  5HTOTAL, 10X,  4HAREA  /                    00202**7
     2 25X,               4HAREA,  10X, 6HNEEDED   /  )                 00203**7
CDEL  WRITE (SYSOUT,1002) BRSUB(N),AREA(N),A(N)                         00204
 1002 FORMAT (10X,A,5X,F12.1,5X,F10.1)                                  00205*10
CDEL  CALL PAGE                                                         00206*12
      GO TO 407                                                         00207
      END                                                               00208
      SUBROUTINE RC7                                                    00001
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00003
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00004
      RETURN                                                            00005
      END                                                               00006
      SUBROUTINE RC9(I,J,*)                                             00007**5
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00009
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00010
CDEL  WRITE (SYSOUT,1000)                                               00011
1000  FORMAT (' ROUTINE TO ANALYZE A MULTIPLE OPENING BRIDGE IS NOT AVAI00012
     1LABLE')                                                           00013
      J=1                                                               00014
      RETURN                                                            00015
      END                                                               00016
      SUBROUTINE RC10                                                   00017
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00019
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00020
      RETURN                                                            00021
      END                                                               00022
      SUBROUTINE RC13                                                   00023
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00025
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00026
CDEL  WRITE (SYSOUT,1000)                                               00027
1000  FORMAT (' ROUTINE TO DESIGN  STRAIGHT, CIRCULAR CULVERT WITH DROP 00028
     1INLET IS NOT AVAILABLE')                                          00029
      RETURN                                                            00030
      END                                                               00031
      SUBROUTINE RC15                                                   00032
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00034
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00035
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```
CDEL  WRITE (SYSOUT,1000)                                                 00036
1000  FORMAT (' ROUTINE TO DESIGN  STRAIGHT, ARCH CULVERT WITH DROP INLE00037
     1T IS NOT AVAILABLE')                                                00038
      RETURN                                                              00039
      END                                                                 00040
      SUBROUTINE RC16                                                     00041
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),                00043
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00044
CDEL  WRITE (SYSOUT,1000)                                                 00045
1000  FORMAT (' ROUTINE TO DESIGN  STRAIGHT, OVAL CULVERT WITH NORMAL IN00046
     1LET IS NOT AVAILABLE')                                              00047
      RETURN                                                              00048
      END                                                                 00049
      SUBROUTINE RC17                                                     00050
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),                00052
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00053
CDEL  WRITE (SYSOUT,1000)                                                 00054
1000  FORMAT (' ROUTINE TO DESIGN  STRAIGHT, OVAL CULVERT WITH DROP INLE00055
     1T IS NOT AVAILABLE')                                                00056
      RETURN                                                              00057
      END                                                                 00058
      SUBROUTINE RC19                                                     00059
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),                00061
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00062
CDEL  WRITE (SYSOUT,1000)                                                 00063
1000  FORMAT (' ROUTINE TO DESIGN  STRAIGHT, BOX CULVERT WITH FLARED INL00064
     1ET IS NOT AVAILABLE')                                               00065
      RETURN                                                              00066
      END                                                                 00067
      SUBROUTINE RC20                                                     00068
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),                00070
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00071
CDEL  WRITE (SYSOUT,1000)                                                 00072
1000  FORMAT (' ROUTINE TO DESIGN  STRAIGHT, BOX CULVERT WITH DROP INLET00073
     1 IS NOT AVAILABLE')                                                 00074
      RETURN                                                              00075
      END                                                                 00076
      SUBROUTINE RC21                                                     00077
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),                00079
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00080
CDEL  WRITE (SYSOUT,1000)                                                 00081
1000  FORMAT (' ROUTINE TO DESIGN  BROKEN-BACK CIRCULAR CULVERT WITH NOR00082
     1MAL INLET IS NOT AVAILABLE')                                        00083
      RETURN                                                              00084
      END                                                                 00085
      SUBROUTINE RC22                                                     00086
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),                00088
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00089
CDEL  WRITE (SYSOUT,1000)                                                 00090
1000  FORMAT (' ROUTINE TO DESIGN  BROKEN-BACK CIRCULAR CULVERT WITH FLA00091
     1RED INLET IS NOT AVAILABLE')                                        00092
      RETURN                                                              00093
      END                                                                 00094
      SUBROUTINE RC23                                                     00095
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),                00097
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00098
CDEL  WRITE (SYSOUT,1000)                                                 00099
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1000  FORMAT (' ROUTINE TO DESIGN BROKEN-BACK CIRCULAR CULVERT WITH DROP00100
     1 INLET IS NOT AVAILABLE')                                          00101
      RETURN                                                             00102
      END                                                                00103
      SUBROUTINE RC24                                                    00104
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),               00106
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00107
CDEL  WRITE (SYSOUT,1000)                                                00108
1000  FORMAT (' ROUTINE TO DESIGN  BROKEN-BACK ARCH CULVERT WITH NORMAL 00109
     1INLET IS NOT AVAILABLE')                                           00110
      RETURN                                                             00111
      END                                                                00112
      SUBROUTINE RC25                                                    00113
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),               00115
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00116
CDEL  WRITE (SYSOUT,1000)                                                00117
1000  FORMAT (' ROUTINE TO DESIGN  BROKEN-BACK ARCH CULVERT WITH DROP IN00118
     1LET IS NOT AVAILABLE')                                             00119
      RETURN                                                             00120
      END                                                                00121
      SUBROUTINE RC26                                                    00122
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),               00124
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00125
CDEL  WRITE (SYSOUT,1000)                                                00126
1000  FORMAT (' ROUTINE TO DESIGN  BROKEN-BACK OVAL CULVERT WITH NORMAL 00127
     1INLET IS NOT AVAILABLE')                                           00128
      RETURN                                                             00129
      END                                                                00130
      SUBROUTINE RC27                                                    00131
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),               00133
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00134
CDEL  WRITE (SYSOUT,1000)                                                00135
1000  FORMAT (' ROUTINE TO DESIGN  BROKEN-BACK OVAL CULVERT WITH DROP IN00136
     1LET IS NOT AVAILABLE')                                             00137
      RETURN                                                             00138
      END                                                                00139
      SUBROUTINE RC28                                                    00140
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),               00142
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00143
CDEL  WRITE (SYSOUT,1000)                                                00144
1000  FORMAT (' ROUTINE TO DESIGN  BROKEN-BACK BOX CULVERT WITH NORMAL I00145
     1NLET IS NOT AVAILABLE')                                            00146
      RETURN                                                             00147
      END                                                                00148
      SUBROUTINE RC29                                                    00149
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),               00151
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00152
CDEL  WRITE (SYSOUT,1000)                                                00153
1000  FORMAT (' ROUTINE TO DESIGN  BROKEN-BACK BOX CULVERT WITH FLARED I00154
     1NLET IS NOT AVAILABLE')                                            00155
      RETURN                                                             00156
      END                                                                00157
      SUBROUTINE RC30                                                    00158
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),               00160
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV      00161
CDEL  WRITE (SYSOUT,1000)                                                00162
1000  FORMAT (' ROUTINE TO DESIGN  BROKEN-BACK BOX CULVERT WITH DROP INL00163
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     1ET IS NOT AVAILABLE')                                            00164
      RETURN                                                           00165
      END                                                              00166
      SUBROUTINE RC31                                                  00167
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),             00169
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV    00170
CDEL  WRITE (SYSOUT,1000)                                              00171
1000  FORMAT (' ROUTINE TO DESIGN  STEPPED CIRCULAR CULVERT WITH NORMAL 00172
     1INLET IS NOT AVAILABLE')                                         00173
      RETURN                                                           00174
      END                                                              00175
      SUBROUTINE RC32                                                  00176
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),             00178
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV    00179
CDEL  WRITE (SYSOUT,1000)                                              00180
1000  FORMAT (' ROUTINE TO DESIGN  STEPPED CIRCULAR CULVERT WITH FLARED 00181
     1INLET IS NOT AVAILABLE')                                         00182
      RETURN                                                           00183
      END                                                              00184
      SUBROUTINE RC33                                                  00185
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),             00187
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV    00188
CDEL  WRITE (SYSOUT,1000)                                              00189
1000  FORMAT (' ROUTINE TO DESIGN  STEPPED CIRCULAR CULVERT WITH DROP IN00190
     1LET IS NOT AVAILABLE')                                           00191
      RETURN                                                           00192
      END                                                              00193
      SUBROUTINE RC34                                                  00194
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),             00196
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV    00197
CDEL  WRITE (SYSOUT,1000)                                              00198
1000  FORMAT (' ROUTINE TO DESIGN  STEPPED ARCH CULVERT WITH NORMAL INLE00199
     1T IS NOT AVAILABLE')                                             00200
      RETURN                                                           00201
      END                                                              00202
      SUBROUTINE RC35                                                  00203
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),             00205
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV    00206
CDEL  WRITE (SYSOUT,1000)                                              00207
1000  FORMAT (' ROUTINE TO DESIGN  STEPPED ARCH CULVERT WITH DROP INLET 00208
     1IS NOT AVAILABLE')                                               00209
      RETURN                                                           00210
      END                                                              00211
      SUBROUTINE RC36                                                  00212
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),             00214
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV    00215
CDEL  WRITE (SYSOUT,1000)                                              00216
1000  FORMAT (' ROUTINE TO DESIGN  STEPPED OVAL CULVERT WITH NORMAL INLE00217
     1T IS NOT AVAILABLE')                                             00218
      RETURN                                                           00219
      END                                                              00220
      SUBROUTINE RC37                                                  00221
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),             00223
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV    00224
CDEL  WRITE (SYSOUT,1000)                                              00225
1000  FORMAT (' ROUTINE TO DESIGN  STEPPED OVAL CULVERT WITH DROP INLET 00226
     1IS NOT AVAILABLE')                                               00227
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      RETURN
      END
      SUBROUTINE RC38
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO DESIGN  STEPPED BOX CULVERT WITH NORMAL INLET
     1 IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC39
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO DESIGN  STEPPED BOX CULVERT WITH DROP INLET I
     1S NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC42
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE STRAIGHT, CIRCULAR CULVERT WITH DROP
     1INLET IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC44
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE STRAIGHT, ARCH CULVERT WITH DROP INLE
     1T IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC45
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE STRAIGHT, OVAL CULVERT WITH NORMAL IN
     1LET IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC46
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE STRAIGHT, OVAL CULVERT WITH DROP INLE
     1T IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC48
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE STRAIGHT, BOX CULVERT WITH FLARED INL
     1ET IS NOT AVAILABLE')
      RETURN
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      END                                                               00292
      SUBROUTINE RC49                                                   00293
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00295
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00296
CDEL  WRITE (SYSOUT,1000)                                               00297
1000  FORMAT (' ROUTINE TO ANALYZE STRAIGHT, BOX CULVERT WITH DROP INLET00298
     1 IS NOT AVAILABLE')                                               00299
      RETURN                                                            00300
      END                                                               00301
      SUBROUTINE RC51                                                   00302
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00304
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00305
CDEL  WRITE (SYSOUT,1000)                                               00306
1000  FORMAT (' ROUTINE TO ANALYZE BROKEN-BACK CIRCULAR CULVERT WITH FLA00307
     1RED INLET IS NOT AVAILABLE')                                      00308
      RETURN                                                            00309
      END                                                               00310
      SUBROUTINE RC52                                                   00311
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00313
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00314
CDEL  WRITE (SYSOUT,1000)                                               00315
1000  FORMAT (' ROUTINE TO ANALYZE BROKEN-BACK CIRCULAR CULVERT WITH DRO00316
     1P INLET IS NOT AVAILABLE')                                        00317
      RETURN                                                            00318
      END                                                               00319
      SUBROUTINE RC53                                                   00320
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00322
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00323
CDEL  WRITE (SYSOUT,1000)                                               00324
1000  FORMAT (' ROUTINE TO ANALYZE BROKEN-BACK ARCH CULVERT WITH NORMAL 00325
     1INLET IS NOT AVAILABLE')                                          00326
      RETURN                                                            00327
      END                                                               00328
      SUBROUTINE RC54                                                   00329
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00331
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00332
CDEL  WRITE (SYSOUT,1000)                                               00333
1000  FORMAT (' ROUTINE TO ANALYZE BROKEN-BACK ARCH CULVERT WITH DROP IN00334
     1LET IS NOT AVAILABLE')                                            00335
      RETURN                                                            00336
      END                                                               00337
      SUBROUTINE RC55                                                   00338
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00340
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00341
CDEL  WRITE (SYSOUT,1000)                                               00342
1000  FORMAT (' ROUTINE TO ANALYZE BROKEN-BACK OVAL CULVERT WITH NORMAL 00343
     1INLET IS NOT AVAILABLE')                                          00344
      RETURN                                                            00345
      END                                                               00346
      SUBROUTINE RC56                                                   00347
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00349
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00350
CDEL  WRITE (SYSOUT,1000)                                               00351
1000  FORMAT (' ROUTINE TO ANALYZE BROKEN-BACK OVAL CULVERT WITH DROP IN00352
     1LET IS NOT AVAILABLE')                                            00353
      RETURN                                                            00354
      END                                                               00355
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      SUBROUTINE RC58
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE BROKEN-BACK BOX CULVERT WITH FLARED I
     1NLET IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC59
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE BROKEN-BACK BOX CULVERT WITH DROP INL
     1ET IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC60
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE STEPPED CIRCULAR CULVERT WITH NORMAL
     1INLET IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC61
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE STEPPED CIRCULAR CULVERT WITH FLARED
     1INLET IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC62
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE STEPPED CIRCULAR CULVERT WITH DROP IN
     1LET IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC63
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE STEPPED ARCH CULVERT WITH NORMAL INLE
     1T IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC64
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV
CDEL  WRITE (SYSOUT,1000)
1000  FORMAT (' ROUTINE TO ANALYZE STEPPED ARCH CULVERT WITH DROP INLET
     1IS NOT AVAILABLE')
      RETURN
      END
      SUBROUTINE RC65
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      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00421
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00422
CDEL  WRITE (SYSOUT,1000)                                               00423
1000  FORMAT (' ROUTINE TO ANALYZE STEPPED OVAL CULVERT WITH NORMAL INLE00424
     1T IS NOT AVAILABLE')                                              00425
      RETURN                                                            00426
      END                                                               00427
      SUBROUTINE RC66                                                   00428
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00430
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00431
CDEL  WRITE (SYSOUT,1000)                                               00432
1000  FORMAT (' ROUTINE TO ANALYZE STEPPED OVAL CULVERT WITH DROP INLET 00433
     1IS NOT AVAILABLE')                                                00434
      RETURN                                                            00435
      END                                                               00436
      SUBROUTINE RC67                                                   00437
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00439
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00440
CDEL  WRITE (SYSOUT,1000)                                               00441
1000  FORMAT (' ROUTINE TO ANALYZE STEPPED BOX CULVERT WITH NORMAL INLET00442
     1 IS NOT AVAILABLE')                                               00443
      RETURN                                                            00444
      END                                                               00445
      SUBROUTINE RC68                                                   00446
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00448
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00449
CDEL  WRITE (SYSOUT,1000)                                               00450
1000  FORMAT (' ROUTINE TO ANALYZE STEPPED BOX CULVERT WITH FLARED INLET00451
     1 IS NOT AVAILABLE')                                               00452
      RETURN                                                            00453
      END                                                               00454
      SUBROUTINE RC69                                                   00455
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00457
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00458
CDEL  WRITE (SYSOUT,1000)                                               00459
1000  FORMAT (' ROUTINE TO ANALYZE STEPPED BOX CULVERT WITH DROP INLET I00460
     1S NOT AVAILABLE')                                                 00461
      RETURN                                                            00462
      END                                                               00463
      SUBROUTINE RC8 (X,Y,J,NPTS)                                       00001
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH       00002*14
      INTEGER SHAPE,PROFIL,OPENGS                                       00003*10
      DOUBLE PRECISION X100                                             00004*14
      COMMON ACRES,CA,FREQ,QPEAK,TC,      ISECN(50,50),ISTA(50),        00005
     1 SKEW,WATEL,WESTA,NSEC,NSUBSC(50),NTOTPT(50)                      00006*10
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00007
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00008
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00009**9
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00010*13
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00011**9
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00012**9
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00014*10
      COMMON/F100/N100,CLREL,HEL,Q100,V100,WTL100,X100(100),Y100(100)   00015
      DIMENSION X(100),Y(100)                                           00016
C                                                                       00017
C  SINGLE BRIDGE ANALYSIS                                               00018
C                                                                       00019
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  100 IF(KC(29).EQ.1) GO TO 118
      WTL=WATEL
      IF(KC(28).EQ.1.AND.WATEL.GT.CLREL) WTL=CLREL
      Q1=QPEAK
      NN=NPTS-1
      SUMAU=0.0
      NO=1
      DO 120 N=1,NN
       X1=X(N)
       Y1=Y(N)
       X2=X(N+1)
       Y2=Y(N+1)
       NEXT=1
       IF (X2.LE.FROMX(NO)) GO TO 101
       IF (X1.GT.FROMX(NO)) GO TO 102
C
C BEGIN COMPILATION OF BRIDGE CROSS-SECTIONAL AREA AT STATION 'FROMX'
C
       X2=FROMX(NO)
       Y2=(FROMX(NO)-X1)/(X(N+1)-X(N))*(Y(N+1)-Y(N))+Y1
       SUMBR=LFTSS(NO)*AMAX1((WTL-Y2),0.)
       SUMAR=SUMBR/2.*(WTL-Y2)
       NEXT=2
       GO TO 101
102    IF (X1.GE.TOX(NO)) GO TO 101
       IF (X2.LT.TOX(NO)) GO TO 101
C
C END COMPILATION OF BRIDGE CROSS-SECTIONAL AREA AT STATION 'TOX'
C
111    X2=TOX(NO)
       Y2=(TOX(NO)-X1)/(X(N+1)-X(N))*(Y(N+1)-Y(N))+Y1
       BR=RGTSS(NO)*AMAX1((WTL-Y2),0.0)
       SUMBR=SUMBR+BR
       SUMAR=SUMAR+BR*(WTL-Y2)/2.0
       NEXT=3
  101  H1U=WATEL-Y1
       H2U=WATEL-Y2
       XTMP=ABS(X2-X1)
C
C BOTH ADJACENT GROUND POINTS UNDER WATER
C
       IF(H1U.GE.0.0.AND.H2U.GE.0.0) GO TO 103
C
C ONE OR OTHER ADJACENT GROUND POINT UNDER WATER
C
       IF(H1U.LT.0.0.AND.H2U.GT.0.0) GO TO 104
       IF(H1U.GT.0.0.AND.H2U.LT.0.0) GO TO 105
       GO TO 107
C
C CALCULATION FOR WATER AREA (A) AND WATER WIDTH (B)
C
  103  BU=XTMP
       AU=BU*(H1U+H2U)/2.0
       GO TO 106
  104  BU=H2U*XTMP/(H2U-H1U)
       AU=BU*H2U/2.0
       GO TO 106
```

```
  105  BU=H1U*XTMP/(H1U-H2U)
       AU=BU*H1U/2.0
  106  SUMAU=SUMAU+AU
C
C TEST IF AREA (A) IS TO BE INCLUDED IN BRIDGE AREA
C
       IF (KC(36).NE.1) GO TO 107
      H1R=WTL-Y1
      H2R=WTL-Y2
       IF(H1R.GE.0.0.AND.H2R.GE.0.0) GO TO 203
       IF(H1R.LT.0.0.AND.H2R.GT.0.0) GO TO 204
       IF(H1R.GT.0.0.AND.H2R.LT.0.0) GO TO 205
  203  BR=XTMP
       AR=BR*(H1R+H2R)/2.0
       GO TO 206
  204  BR=H2R*XTMP/(H2R-H1R)
       AR=BR*H2R/2.0
       GO TO 206
  205  BR=H1R*XTMP/(H1R-H2R)
       AR = BR*H1R/2.0
  206  SUMAR=SUMAR+AR
       SUMBR=SUMBR+BR
C
C IF: NEXT=1, POINTS WERE PROCESSED PROPERLY
C     NEXT=2, FROMX FELL BETWEEN SECTION POINTS
C     NEXT=3, TOX FELL BETWEEN SECTION POINTS
C
107    GO TO (120,108,109), NEXT
108    X1=X2
       Y1=Y2
      X2=X(N+1)
      Y2=Y(N+1)
       KC(36)=1
       IF (X2.LT.TOX(NO)) GO TO 110
       GO TO 111
109    Y1=Y2
       X1=X2
       KC(36)=0
       X2=X(N+1)
       Y2=Y(N+1)
 110   NEXT=1
       GO TO 101
120    CONTINUE
  118 IF(KC(28).EQ.0) GO TO 121
      Q1=Q100
      KC(29)=1
C
C VELOCITY CALCULATION (THROUGH EXISTING BRIDGE)
C
  121 VELOC(1)=QPEAK/SUMAR
C
C VELOCITY CALCULATION (UNRESTRICTED)
C
      VELOC(2)=Q1/SUMAU
C
C BACKWATER CALCULATION
C BWH CALCULATION MAY BE SOPHISTICATED IN THE FUTURE
```

```
C                                                                       00134
      BWH=(VELOC(1)**2-VELOC(2)**2)/64.4                                00135
      LEN(1)=SUMBR                                                      00136
      IF(KC(28).EQ.0) GO TO 122                                         00137
      BWH=(VELOC(1)**2/0.64-VELOC(2)**2)/64.4                           00138
      RETURN                                                            00139
C                                                                       00140
C REPORT TO PRINT RESULTS OF ANALYSIS                                   00141
C                                                                       00142
 122  CONTINUE
CDEL  CALL BRRPT (FROMX(NO),TOX(NO),J)                                  00143
      RETURN                                                            00144
      END                                                               00145
      SUBROUTINE RC99(INSTA1,OUTST1,INEL1,OUTEL1,*)                     00001*32
      DOUBLE PRECISION X100                                             00002*31
      REAL MANN,INSTA,INEL,MAXHW,ISECN,ISTA,KECF,LEN,LFTSS,LENGTH,      00003*21
     1 INSTA1,INEL1,L                                                   00004*21
      INTEGER SHAPE,PROFIL,OPENGS,B                                     00005*31
      CHARACTER*3 ROADID,CLVTID,BRSUB,NAME                              00006*32
      CHARACTER*4 FLSEC,ORIGID,MATL,MATRL                               00007*32
      DIMENSION MATL(3)                                                 00008*32
      COMMON ACRES,CA,FREQ,QPEAK,TC,ISECN(50,50),ISTA(50),SKEW,WATEL,   00009
     1 WESTA,NSEC,NSUBSC(50),NTOTPT(50)                                 00010*26
      COMMON/KCOM/KSYS,KA(99),KB(99),KC(99),KD(99),KE(99),              00011
     1 LILC,LRLC,LILF,LRLF,IGATE,QSOFF,HSOFF,TWSOFF,VWSOFF,HWXC,TWV     00012
      COMMON/CCOM/BBLS,BREL(4),BRSTA(4),BWH,CONV(10),CRSLPE,DEPTH,      00013*23
     1 DIFT,DIAM,DNSS,FLOW(10),FROMX(10),HIGH,HIFT,WIFT,INEL,INSTA,KECF,00014*31
     2 LEN(10),LENGTH,LFTSS(10),MANN,MAXHW,OUTEL,OUTSTA,PC(10),         00015*23
     3 PFLOW(10),RGTSS(10),SLOPE,SLP(5),TOX(10),UPSS,VELOC(10),         00016*23
     4 VMAX,VMAXB(10),VMIN(10),VO,WIDE,INLET,MAT,OPENGS,PROFIL,SHAPE    00017*26
      COMMON/CCOM1/ BRSUB(10),CLVTID,FLSEC,NAME,ORIGID,ROADID           00018*26
      COMMON/FCOM/HW(100),SL(100),V(100),B(100),H(100),IQP(100),        00019*31
     1 L(100),NUMCUL,W(100)                                             00020*31
      COMMON/F100/N100,CLREL,HEL,Q100,V100,WTL100,X100(100),Y100(100)   00021
      DATA MATL/' RCP',' CGM','    '/                                   00022*21
      KC(28)=1                                                          00023
      SAVINS=INSTA                                                      00024
      SAVOTS=OUTSTA                                                     00025
      SAVINL=INEL                                                       00026
      SAVOTL=OUTEL                                                      00027
      IF(N100.GT.0) GO TO 2                                             00028
CDEL  WRITE(SYSOUT,5000)                                                00029
 5000 FORMAT(41H CLB0105--ROAD PROFILE DATA NOT PROVIDED.  /)           00030*28
CDEL  CALL PAGE                                                         00031*28
      GO TO 3000                                                        00032*20
    2 NCHCK=N100-1                                                      00033
      NIX=0                                                             00034
      DO 120 I=1,NCHCK                                                  00035
       IF(Y100(I+1).LT.Y100(I)) GO TO 122                               00036
  120 NIX=NIX+1                                                         00037
      GO TO 141                                                         00038
  122 IF(NIX.EQ.0) GO TO 126                                            00039
      N100=N100-NIX                                                     00040
      DO 124 I=1,N100                                                   00041
       X100(I)=X100(I+NIX)                                              00042
  124 Y100(I)=Y100(I+NIX)                                               00043
      NCHCK=NCHCK-NIX                                                   00044
```

```
  126 NOX=0                                                             00045
      DO 140 I=1,NCHCK                                                  00046
       IX=N100+1-I                                                      00047
       IF(Y100(IX-1).LT.Y100(IX)) GO TO 142                             00048
  140 NOX=NOX+1                                                         00049
  141 CONTINUE
CDEL  WRITE(SYSOUT,33)                                                  00050
33    FORMAT (  56H CLB0106--HIGHWAY PROFILE DOES NOT FORM A VALID SECTI00051*20
     $ON.   /)                                                          00052*28
CDEL  CALL PAGE                                                         00053*28
      GO TO 3000                                                        00054*20
  142 IF(NOX.GT.0) N100=N100-NOX                                        00055
CDEL  IF(NIX+NOX.GT.0) WRITE(SYSOUT,34)                                 00056
34    FORMAT (  68H CLB0107--SUPERFLUOUS POINTS HAVE BEEN DELETED FROM H00057*20
     $IGHWAY PROFILE. )                                                 00058*20
      IF(N100.GE.3) GO TO 3                                             00059
CDEL  WRITE(SYSOUT,30)                                                  00060
30    FORMAT (  71H CLB0108--HIGHWAY PROFILE DOES NOT HAVE AT LEAST THRE00061*20
     $E X Y COORDINATES.   /)                                           00062*28
CDEL  CALL PAGE                                                         00063*28
      GO TO 3000                                                        00064*20
    3 HEL=Y100(1)                                                       00065
      DO 4 I=2,N100                                                     00066
      IF(Y100(I).LT.HEL) HEL=Y100(I)                                    00067
    4 CONTINUE                                                          00068
      HELMAX=Y100(1)                                                    00069
      IF(Y100(N100).LT.Y100(1)) HELMAX=Y100(N100)                       00070
      SAVQPK=QPEAK                                                      00071
      SAVFRQ=FREQ                                                       00072
      SAVWTL=WATEL                                                      00073
      QPEAK=Q100                                                        00074
      WATEL=WTL100                                                      00075
      FREQ=100                                                          00076
      ICOUNT=0                                                          00077
      IF(KC(2).EQ.1) GO TO 600                                          00078
C                                                                       00079
C **** DESIGN SPECIFIED ****                                            00080
C                                                                       00081
      IF(KC(4).EQ.1) GO TO 200                                          00082
C                                                                       00083
C **** BRIDGE DESIGN SPECIFIED ****                                     00084
C                                                                       00085
      GO TO 400                                                         00086
C                                                                       00087
C **** CULVERT DESIGN SPECIFIED ****                                    00088
C                                                                       00089
  200 WID=W(NUMCUL)                                                     00090*31
      IH=H(NUMCUL)+0.1                                                  00091*31
      LENGTH=L(NUMCUL)                                                  00092
      BBLS=B(NUMCUL)                                                    00093
      IF(WID.GT.0.0.AND.LENGTH.GT.0.0.AND.BBLS.GT.0.0) GO TO 203        00094*31
CDEL  WRITE(SYSOUT,5004)                                                00095
 5004 FORMAT (42H CLB0109--CULVERT DIMENSIONS NOT SUPPLIED.  /)         00096*28
CDEL  CALL PAGE                                                         00097*28
      GO TO 2000                                                        00098
  203 IF(KC(2).EQ.1) GO TO 110                                          00099
      INSTA=INSTA1                                                      00100
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      OUTSTA=OUTST1                                                     00101
      INEL=INEL1                                                        00102
      OUTEL=OUTEL1                                                      00103
CPC
      BWHEL = 0.0
C                                        PERMIT 100 YR CALCULATIONS. 00104*21
110   GO TO ( 2201, 2402, 1999, 201 ), SHAPE                         00105*21
      GO TO 1999                                                     00106*21
2201  IF ( PROFIL .EQ. 2 ) GO TO 2500                                00107*21
      IF ( PROFIL .NE. 1 ) GO TO 1999                                00108*21
      IF ( INLET  .EQ. 3 ) GO TO 2300                                00109*21
      IF ( INLET  .NE. 1 ) GO TO 1999                                00110*21
      CALL RC41 (BWHEL,*2000)                                        00111*32
      ISUB = 4                                                       00112*21
      GO TO 202                                                      00113*21
2300  CONTINUE
      IF(IGATE.EQ.0)CALL RC40   (BWHEL,QPP,CRITD,TW,*2000)           00114*32
      IF(IGATE.EQ.1)CALL RC40FLP(BWHEL,QPP,CRITD,TW,*2000)
      IF(IGATE.EQ.2)CALL RC40FLX(BWHEL,QPP,CRITD,TW,*2000)
C2300 CALL RC40(BWHEL,QPP,CRITD,TW,*2000)                             00114*32
      ISUB = 3                                                       00115*21
      GO TO 202                                                      00116*21
2402  IF ( PROFIL .NE. 1 ) GO TO 1999                                00117*21
      CALL RC43 ( BWHEL, *2000 )                                     00118*26
      ISUB = 6                                                       00119*21
      GO TO 202                                                      00120*21
 2500 CALL RC50(BWHEL,*2000)                                         00121*31
      ISUB = 5                                                       00122*21
      GO TO 202                                                      00123*21
  201 GO TO (230,214),PROFIL                                         00124*31
      GO TO 2000                                                        00125
  214 IF(INLET.EQ.3) GO TO 240                                          00126
      GO TO 2000                                                        00127
  230 IF(INLET.EQ.3) GO TO 233                                          00128
      GO TO 2000                                                        00129
  233 CONTINUE
      IF(IGATE.EQ.0)CALL RC47   (BWHEL,*2000)                        00130*32
      IF(IGATE.EQ.1)CALL RC47FLP(BWHEL,*2000)
      IF(IGATE.EQ.2)CALL RC47FLP(BWHEL,*2000)
C 233 CALL RC47(BWHEL,*2000)                                         00130*32
      ISUB = 1                                                       00131*21
      GO TO 202                                                         00132
 240  IF(MANN.EQ.1.) MANN=0.012                                         00133
      IF(MANN.EQ.2.0) MANN=0.024                                     00134*19
      IF(MANN.EQ.3.) MANN=10.**((ALOG10(DIFT+10.)-4.15076)/(-5.77698)   00135*31
     1 -2.)                                                             00136
      CALL RC57(BWHEL,*2000)                                         00137*26
      ISUB = 2                                                       00138*21
  202 HW100=BWHEL                                                       00139
      HE=HEL-INEL                                                       00140
      HH=0.0                                                            00141
      IF(HW100.LE.HEL) GO TO 260                                        00142
      HS=HW100-INEL                                                     00143
      HH=HS-HE                                                          00144
      IF(HH.GT.0.0) KC(21)=1                                         00145*32
      HADJ=HH                                                           00146
      MINUS=0                                                        00147*32
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  207 CALL RC100(HH)                                                    00148
      IF(QPEAK.GT.0.001) GO TO 209                                      00149
      HADJ=-0.5*ABS(HADJ)                                               00150
      GO TO 250                                                         00151
209   GO TO ( 221, 222, 223, 224, 225, 226 ), ISUB                      00152*21
  221 CONTINUE
      IF(IGATE.EQ.0)CALL RC47   (BWHEL,*2000)                           00153*32
      IF(IGATE.EQ.1)CALL RC47FLP(BWHEL,*2000)
      IF(IGATE.EQ.2)CALL RC47FLP(BWHEL,*2000)
C 221 CALL RC47 (BWHEL,*2000)                                           00153*32
      GO TO 215                                                         00154*21
222   CALL RC57 ( BWHEL, *2000 )                                        00155*26
      GO TO 215                                                         00156*21
  223 CONTINUE
      IF(IGATE.EQ.0)CALL RC40   (BWHEL,QPP,CRITD,TW,*2000)              00157*32
      IF(IGATE.EQ.1)CALL RC40FLP(BWHEL,QPP,CRITD,TW,*2000)
      IF(IGATE.EQ.2)CALL RC40FLX(BWHEL,QPP,CRITD,TW,*2000)
C 223 CALL RC40 (BWHEL,QPP,CRITD,TW,*2000)                              00157*32
      GO TO 215                                                         00158*21
  224 CALL RC41 (BHWEL,*2000)                                           00159*32
      GO TO 215                                                         00160*21
  225 CALL RC50(BWHEL,*2000)                                            00161*31
      GO TO 215                                                         00162*21
226   CALL RC43 ( BWHEL, *2000 )                                        00163*26
  215 HS=BWH                                                            00164
      HTEST=HH+HE-HS                                                    00165
      FACT = 0.001                                                      00166*32
      IF (HE+HH.LT.3.0) FACT=0.005                                      00167*32
      IF(ABS(HTEST).LE.FACT*(HE+HH)) GO TO 208                          00168*32
      HADJ=0.5*ABS(HADJ)                                                00169
      IF(HTEST.GT.0.0) HADJ=-HADJ                                       00170
      IF(ICOUNT.GE.20.AND.HADJ.LT.0.0) MINUS = MINUS + 1                00171*32
  250 HH=HH+HADJ                                                        00172
      ICOUNT=ICOUNT+1                                                   00173
      IF(ICOUNT.LT.30) GO TO 207                                        00174
      IF(MINUS.GT.0.AND.MINUS.LT.10) GO TO 206                          00175*32
CDEL  WRITE(SYSOUT,9901)                                                00176
9901  FORMAT (  55H CLB0111--UNABLE TO ACHIEVE BALANCE FOR 100 YEAR FLOO00177*20
     $D.  /)                                                            00178*28
CDEL  CALL PAGE                                                         00179*28
      GO TO 2000                                                        00180
  206 CONTINUE
CDEL  WRITE (SYSOUT,9902)                                               00181*32
 9902 FORMAT (' CLB0115--DUE TO PROBLEMS IN CONVERGENCE THE 100 YEAR',  00182*32
     1 ' ANALYSIS RESULTS SHOULD BE CONSIDERED CAREFULLY SINCE THEY ',  00183*32
     2 'MAY BE IN ERROR')                                               00184*32
  208 HW100=HEL+HH                                                      00185
  260 IBBLS=BBLS                                                        00186
      IDIAM=DIAM+0.1                                                    00187*31
CDEL  CALL PAGE                                                         00188*28
CDEL  WRITE(SYSOUT,5306)                                                00189
 5306 FORMAT(/10X,'H U N D R E D   Y E A R   F L O O D   A N A L Y S I S00190*28
     1',//)                                                             00191*28
      IF(DIAM.GT.0.01) GO TO 210                                        00192*21
      IWD=WID+0.1                                                       00193*31
CDEL  WRITE(SYSOUT,5312)CLVTID,IBBLS,IWD,IH,LENGTH                      00194
 5312 FORMAT(10X,'CULVERT ',A3,3X,I3,' -',I3,' X',I3,' X',F7.2,/)       00195
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      GO TO 205                                                         00196*21
  210 GO TO (213,216), MAT                                              00197*21
      MATRL=MATL(3)                                                     00198*21
      GO TO 218                                                         00199*21
  213 MATRL=MATL(1)                                                     00200*21
      GO TO 218                                                         00201*21
  216 MATRL=MATL(2)                                                     00202*21
  218 CONTINUE
CDEL  WRITE(SYSOUT,5313) CLVTID,IBBLS,IDIAM,LENGTH,MATRL                00203*21
 5313 FORMAT(10X,'CULVERT ',A3,3X,I3,' -',I3,' X',F7.2,2X,A4/)          00204*21
  205 CONTINUE
CDEL  WRITE(SYSOUT,5316) Q100,VO,WTL100                                 00205*21
 5316 FORMAT(10X,'BASIC FLOOD APPLIED (100 YEAR FREQ) =',F10.1,' CFS',//00206
     1 10X,'HUNDRED YEAR VELOCITY AT STRUCTURE OUTLET =',F5.2,//10X,    00207
     2 'HUNDRED YEAR TAILWATER ELEVATION = ',F7.2/)                     00208
      IF(HH.GT.0.001) GO TO 212                                         00209
CDEL  WRITE(SYSOUT,5308) HW100,HEL                                      00210
 5308 FORMAT(10X,'HEADWATER ELEVATION ON STRUCTURE = ',F7.2,//10X,      00211
     1 'LOW ELEVATION OF ROAD PROFILE = ',F7.2,//10X,'GREATEST DEPTH OF 00212
     2FLOW OVER ROAD = NONE',//10X,'PERCENTAGE OF BASIC FLOOD OVER ROAD 00213
     3=  0.00 %',/)                                                     00214*28
CDEL  CALL PAGE                                                         00215*28
      GO TO 2000                                                        00216
 212  PCTOVR=(Q100-QPEAK)/Q100*100.0                                    00217
CDEL  WRITE(SYSOUT,5310) HW100,HEL,HH,PCTOVR                            00218
 5310 FORMAT(10X,'ELEVATION OF WATER SURFACE OVER ROAD = ',F7.2,//10X,  00219
     1 'LOW ELEVATION OF ROAD PROFILE = ',F7.2,//10X,'GREATEST DEPTH OF 00220
     2FLOW OVER ROAD = ',F7.2,//10X,'PERCENTAGE OF BASIC FLOOD OVER ROAD00221
     3 = ',F5.2,'%',/)                                                  00222*17
      HI=HW100                                                          00223*17
      GO TO 413                                                         00224*17
C                                                                       00225
C **** BRIDGE DESIGN SPECIFIED ****                                     00226
C                                                                       00227
  400 IF(CLREL.GT.-900.0) GO TO 410                                     00228
CDEL  WRITE(SYSOUT,1920)                                                00229
1920  FORMAT (  39H CLB0112--NO CLEARANCE ELEVATION GIVEN.  )           00230*20
      GO TO 2000                                                        00231
  410 CALL RC3(*2000)                                                   00232*31
      IF(WTL100.LE.CLREL) GO TO 420                                     00233
      VEL2=VELOC(2)                                                     00234
      SVWTL=WATEL                                                       00235
      WATEL=CLREL                                                       00236
      CALL RC3(*2000)                                                   00237*31
      VEL1=VELOC(1)                                                     00238
      WATEL=SVWTL                                                       00239
      GO TO 422                                                         00240
  420 VEL1=VELOC(1)                                                     00241
      VEL2=VELOC(2)                                                     00242
  422 BWH=(VEL1**2/0.64-VEL2**2)/64.4                                   00243
      HW100=WTL100+BWH                                                  00244
      IF(HW100.GT.HEL) GO TO 424                                        00245
CDEL  WRITE(SYSOUT,1900)                                                00246
 1900 FORMAT(' BACKWATER OF 100 YEAR FLOOD DOES NOT OVERTOP ROADWAY.')  00247
      HH=0.0                                                            00248
      GO TO 421                                                         00249
  424 IF(HW100.GT.HELMAX) HW100=HELMAX                                  00250
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      HH=HW100-HEL                                                      00251
      HADJ=HH                                                           00252
  414 CALL RC100(HH)                                                    00253
      IF(QPEAK.GT.0.001) GO TO 415                                      00254
      HADJ=-0.5*ABS(HADJ)                                               00255
      GO TO 417                                                         00256
  415 CALL RC3(*2000)                                                   00257*31
      BWH=(VELOC(1)**2/0.64-VELOC(2)**2)/64.4                           00258
      HS=BWH+WTL100                                                     00259
      HTEST=HEL+HH-HS                                                   00260
      FACT=0.001                                                        00261*32
      IF(HH.LT.3.0) FACT=0.005                                          00262*32
      IF(ABS(HTEST).LE.FACT*HH) GO TO 421                               00263*32
      HADJ=0.5*ABS(HADJ)                                                00264
      IF(HTEST.GT.0.0)HADJ=-HADJ                                        00265
  417 HH=HH+HADJ                                                        00266
      ICOUNT=ICOUNT+1                                                   00267
      IF(ICOUNT.LT.30) GO TO 414                                        00268
CDEL  WRITE ( SYSOUT, 9901 )                                            00269*20
      GO TO 2000                                                        00270
  421 CONTINUE
CDEL  CALL PAGE                                                         00271*28
CDEL  WRITE (SYSOUT,5306)                                               00272*28
CDEL  WRITE(SYSOUT,5316) Q100,VELOC(1),WTL100                           00273
      IF(HH.GT.0.001) GO TO 412                                         00274
CDEL  WRITE(SYSOUT,1912) HW100                                          00275
 1912 FORMAT(/10X,'GREATEST DEPTH OF FLOW OVER ROAD = NONE',//10X,'ELEVA00276
     1TION OF WATER SURFACE = ',F7.2//10X,'PERCENTAGE OF BASIC FLOOD OVE00277
     2R ROAD = 0.00%',/)                                                00278*28
CDEL  CALL PAGE                                                         00279*28
      GO TO 2000                                                        00280
  412 PCTOVR=(Q100-QPEAK)/Q100*100.0                                    00281
CDEL  WRITE(SYSOUT,1908) HH,HS,PCTOVR                                   00282
 1908 FORMAT(/10X,'GREATEST DEPTH OF FLOW OVER ROAD =',F8.2,//10X,'ELEVA00283
     1TION OF WATER SURFACE OVER ROAD =',F7.2,//10X,'PERCENTAGE OF BASIC00284
     2 FLOOD OVER ROAD =',F5.2,'%',/)                                   00285*17
      HI=HS                                                             00286*17
  413 IF(HI.LE.HELMAX) GO TO 418                                        00287*17
CDEL  WRITE(SYSOUT,1910)                                                00288*17
 1910 FORMAT(' * ROAD PROFILE AS GIVEN DOES NOT ACTUALLY CONTAIN OVER-EM00289*17
     1BANKMENT FLOW,',/,'   THEREFORE,FLOW DISTRIBUTION OF ASSOCIATED EL00290*17
     2EVATIONS MAY BE IN ERROR.')                                       00291*17
  418 CONTINUE
CDEL  CALL PAGE                                                         00292*28
      GO TO 2000                                                        00293
C                                                                       00294
C **** ANALYSIS SPECIFIED ****                                          00295
C                                                                       00296
  600 IF(KC(4).EQ.1) GO TO 800                                          00297
C                                                                       00298
C **** BRIDGE ANALYSIS SPECIFIED ****                                   00299
C                                                                       00300
      IF(OPENGS.GT.1) GO TO 604                                         00301
      GO TO 400                                                         00302
  604 CONTINUE
CDEL  WRITE(SYSOUT,56)                                                  00303
   56 FORMAT(' THYSYS CANNOT PRESENTLY PRODUCE 100 YEAR ANALYSIS FOR MUL00304
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     1TIPLE OPENING BRIDGES.',/)
CDEL  CALL PAGE
      GO TO 2000
C
C **** CULVERT ANALYSIS SPECIFIED ****
C
  800 IF(KC(31).EQ.1) GO TO 802
CDEL  WRITE(SYSOUT,5004)
  802 IH=H(NUMCUL)+0.1
      WID=W(NUMCUL)
      IF(SHAPE.NE.3) GO TO 203
 1999 CONTINUE
CDEL  WRITE ( SYSOUT, 1923 ) SHAPE, PROFIL, INLET, ISUB
 1923 FORMAT ( ' TEST - -  SHAPE=', I3, '   PROFIL=', I3, '   INLET=',
     $      I3, '   ISUB=', I8                                         )
CDEL  WRITE ( SYSOUT, 1922  )
 1922 FORMAT (  96H THYSYS DOES NOT PRESENTLY PROCESS 100 YEAR FREQUENCY
     $ CALCULATIONS FOR THE GIVEN CONFIGURATIONS. /)
CDEL  CALL PAGE
 2000 QPEAK=SAVQPK
      WATEL=SAVWTL
      FREQ=SAVFRQ
      INSTA=SAVINS
      OUTSTA=SAVOTS
      INEL=SAVINL
      OUTEL=SAVOTL
 3000 KC(21)=0
      KC(28)=0
      KC(29) = 0
C              RESET KC(28)=0 TO NON-100 YR CALCULATIONS
      RETURN
      END
```

6.1.12 - GP2.BAS

GP2.BAS is a Basic language graphics program. This program produces a graphical comparison of the assumed and computed diversion hydrographs. This Basic program is compiled basic with GraphPack Professional (Crescent Software, undated) library and subroutine calls. Some of the GraphPak subroutines were customized for SAS applications.

```
REM    GP2.BAS
REM    INPUT REQUIRED    SIDHYD.PLT  (SIDEHYD.PL1 & SIDEHYD.PL2 FOR TWO WEIRS)
REM                      CNTRL.DAT   (CNTRL1.DAT & CNTRL2.DAT FOR TWO WEIRS)
REM                      RETRHYD.OUT
REM                      SIDEHYD.HST ( SIDEHYD.HS1 & SIDEHYD.HS2 FOR TWO WEIRS)
REM
REM    OUTPUT PRODUCED   SCREEN GRAPHIC  & OPTIONAL PRINTER PLOT
REM
REM
DEFINT A-Z
DIM TIME!(300), QO!(300), QN!(300)
'These DECLARE statements are for QuickBASIC 4.0
DIM YINT!(5)
DECLARE SUB SetColors (ForeGround%, BackGround%, Headings%, ZeroAxis%)
DECLARE SUB GPPause ()
DECLARE SUB Prepare ()
DECLARE SUB SetSpacing (SpacingH%, SpacingV%)
DECLARE SUB SetFont (FontNumber%)
DECLARE SUB LineSci (SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType,
   PointType, Colors(), Xstart, Ystart)
DECLARE SUB DrawText (XX%, YY%, Text$, Angle%, Colr%, TextSize#)
DECLARE SUB BoxText (Text$, Colr, x, Y, J, T, FS)
DECLARE SUB SetVideo ()
DECLARE FUNCTION GetTextWidth% (Text$)
DECLARE SUB LoadFont (FontFile$)
DECLARE FUNCTION HercThere%
DECLARE SUB GPExist (FileName$, There)

'==========================================================================
'Setup Screen, Fonts, Tiles, ...
'==========================================================================
'$INCLUDE: 'Simpl1'              'see DEMOGPAK.BAS

CALL SetVideo                    'initiate graphics using the correct Screen

REM SET BACKGROUND TO WHITE, AXES TO BLACK
CALL SetColors(0, 15, 4, 0)

OPEN "C:\H1H2SH\RERNTOL.DAT" FOR INPUT AS #1
FOR I = 1 TO 4
LINE INPUT #1, A$
NEXT I
CLOSE (1)
HOLD$ = MID$(A$, 9, 10)
HOLD = VAL(HOLD$)
Ystart = 7
```

```
CALL GPExist("SIDEHYD.PLT", There)
IF NOT There GOTO 1000

'======================================================================
'Setup GPData% Array for Scientific graphs for one weir case
'======================================================================

CALL SetSpacing(2, 2)
QMAX! = -9999!
QMIN! = 9999!
NCOLS = 0

100 REM CONTINUE
OPEN "SIDEHYD.PLT" FOR INPUT AS #1
NPTS = 0
FOR I = 1 TO 300
IF EOF(1) GOTO 200
NPTS = I
INPUT #1, TIME!(I), A1!, A2!, A3!, A4!, QN!(I), A6!, A7!
IF QN!(I) > QMAX! THEN QMAX! = QN!(I)
IF QN!(I) < QMIN! THEN QMIN! = QN!(I)
NEXT I

200 REM CONTINUE
CLOSE (1)

OPEN "CNTRL.DAT" FOR INPUT AS #1
LINE INPUT #1, L1$
LINE INPUT #1, L2$
LINE INPUT #1, L3$
LINE INPUT #1, L4$
LINE INPUT #1, L5$
LINE INPUT #1, L6$
LINE INPUT #1, L7$
LINE INPUT #1, L8$
LINE INPUT #1, L9$
LINE INPUT #1, L10$
LINE INPUT #1, L11$
LINE INPUT #1, L12$
LINE INPUT #1, L13$
LINE INPUT #1, L14$
LINE INPUT #1, L15$
CLOSE (1)
ITSTEP = VAL(MID$(L5$, 16, 2))
ID0 = VAL(MID$(L5$, 19, 2))
IY0 = VAL(MID$(L5$, 24, 2))
IH0 = VAL(MID$(L5$, 27, 2))
IM0 = VAL(MID$(L5$, 29, 2))
ITIME = VAL(MID$(L10$, 16, 3))
JTIME = VAL(MID$(L11$, 16, 3))

300 REM CONTINUE
OPEN "RETRHYD.OUT" FOR INPUT AS #1

301 REM CONTINUE
LINE INPUT #1, A$
IF INSTR(A$, "HYDRO") = 2 GOTO 302
```

```
GOTO 301
302 REM CONTINUE
IF INSTR(A$, MID$(L14$, 16, LEN(L14$) - 16 + 1)) > 14 GOTO 305
GOTO 301

305 REM CONTINUE
IPTS = 1
RTIME! = -ITSTEP / 60!

306 REM CONTINUE
IF EOF(1) GOTO 400
RTIME! = RTIME! + ITSTEP / 60!
LINE INPUT #1, A$
IF ABS(TIME!(IPTS) - RTIME!) > .001 GOTO 306

QO!(IPTS) = -1! * VAL(MID$(A$, 26, 10))

IF QO!(IPTS) > QMAX! THEN QMAX! = QO!(IPTS)
IF QO!(IPTS) < QMIN! THEN QMIN! = QO!(IPTS)

IPTS = IPTS + 1
GOTO 306

400 REM CONTINUE
CLOSE (1)

'=========================================================================
'Setup for Scientific Graphs - Normal Scientific Graph
'One Weir
'=========================================================================
REDIM XTitle$(1), YTitle$(2 + 1)    'Dim arrays to hold data for the graphs
REDIM SciData!(NPTS, 2, 2), SciDataPts!(NPTS, 2, 2), Colors(2)

MainTitle$ = "One Diversion " + MID$(L15$, 16, 3) + "           "

XTitle$(1) = ""

YTitle$(1) = ""

800  REM DOUBLE GRAPH

REM FIRST GRAPH
Colors(1) = 6
YTitle$(2) = "Assumed"
FOR I = 1 TO NPTS
SciData!(I, 1, 1) = TIME!(I)
SciData!(I, 1, 2) = QO!(I)
NEXT I

REM SECOND GRAPH
Colors(2) = 2
YTitle$(3) = "Computed"
FOR I = 1 TO NPTS
SciData!(I, 2, 1) = TIME!(I)
SciData!(I, 2, 2) = QN!(I)
NEXT I
900 REM CONTINUE
```

```
TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
PointType = 0           '2 means each point plotted is shown as circle

'Draw the normal scientific graph

TMAX! = TIME!(NPTS)
TMIN! = TIME!(1)

MAXYST = 8
YINT!(1) = 1!
YINT!(2) = 2!
YINT!(3) = 2.5
YINT!(4) = 5!
RANGE! = QMAX! - QMIN!

MF! = 1!
910 REM CONTINUE
FOR I = 1 TO 4
YSTEP! = MF! * YINT!(I)
IF RANGE! / YSTEP! < MAXYST - 1 GOTO 920
NEXT I
MF! = MF! * 10!
GOTO 910
920 REM CONTINUE
QMAXT! = 0
FOR I = 1 TO 10
QMAXT! = QMAXT! + YSTEP!
IF QMAXT! > QMAX! GOTO 930
NEXT I
930 REM CONTINUE
QMAX! = QMAXT!
QMINT! = 0
FOR I = 1 TO 10
QMINT! = QMINT! - YSTEP!
IF QMINT! < QMIN! GOTO 940
NEXT I
940 REM CONTINUE
QMIN! = QMINT!
NYSTEP = (QMAX! - QMIN!) / YSTEP! + .0001

GPDat%(5) = INT(TMAX! + 1)                'Maximum value for X axis
GPDat%(6) = INT(TMIN!)                    'Minimum value for X axis
GPDat%(7) = INT(TMAX! + 1) - INT(TMIN!)   'Number of steps for X axis
GPDat%(9) = 0                             'Main Title Color
GPDat%(51) = INT(QMAX!)                   'Maximum value for Y axis
GPDat%(52) = INT(QMIN!)                   'Minimum value for Y axis
GPDat%(53) = NYSTEP                       'Number of steps for Y axis
GPDat%(58) = 0                            'Headings Color
CALL Prepare

GPDat%(37) = 100    'X screen position of the origin
GPDat%(38) = 350    'Y screen position of the origin
GPDat%(39) = 480    'X width of the axis
GPDat%(40) = 290    'Y height of the axis
```

```
CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
    Colors(), Xstart, Ystart)

REM Draw the symbols for one weir and then the points for the legend.
Size = 4
FOR I = 1 TO NPTS
  XX! = GPDat%(37) + GPDat%(39) * (SciData!(I, 1, 1) - LowX!) / DiffX!
  YY! = GPDat%(38) - GPDat%(40) * (SciData!(I, 1, 2) - LowY!) / DiffY!
  CIRCLE (XX!, YY!), Size, Colors(1)
  XX! = GPDat%(37) + GPDat%(39) * (SciData!(I, 2, 1) - LowX!) / DiffX!
  YY! = GPDat%(38) - GPDat%(40) * (SciData!(I, 2, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(2), B
NEXT I

XSym = 19
YSym1 = 403
YSym2 = 420
CIRCLE (XSym, YSym1), Size, Colors(1)
LINE (XSym - Size, YSym2 - Size)-(XSym + Size, YSym2 + Size), Colors(2), B

OPEN "SIDEHYD.HST" FOR INPUT AS #1
LINE INPUT #1, A$
CLOSE (1)

REM WRITE RMSE
x = 460
Y = 300
Colr = 0
CALL DrawText(x, Y, MID$(A$, 3, 15), 0, Colr, TextSize#)

REM WRITE MERN
x = 460
Y = 320
Colr = 0
CALL DrawText(x, Y, MID$(A$, 23, 15), 0, Colr, TextSize#)

x = 310
Y = 395
Colr = 0
CALL DrawText(x, Y, "TIME    (hrs)", 0, Colr, TextSize#)
x = 10
Y = 230
CALL DrawText(x, Y, "Q       (cfs)", 90, Colr, TextSize#)

REM WRITE FILE NAMES, DATE, AND TIME
x = 105
Y = 7
Colr = 0
TL = LEN(L4$) - 15
CALL DrawText(x, Y, MID$(L4$, 16, TL), 0, Colr, TextSize#)
x = 105
Y = 24
TL = LEN(L6$) - 15
CALL DrawText(x, Y, MID$(L6$, 16, TL), 0, Colr, TextSize#)
x = 105
Y = 41
TL = LEN(L7$) - 15
```

```
CALL DrawText(x, Y, MID$(L7$, 16, TL), 0, Colr, TextSize#)
x = 535
Y = 41
CALL DrawText(x, Y, MID$(L2$, 16, 10), 0, Colr, TextSize#)
x = Xstart
Y = 41
CALL DrawText(x, Y, MID$(L3$, 16, 10), 0, Colr, TextSize#)

T0! = TIMER
996  IN$ = INKEY$
     IF IN$ = "" GOTO 999

997  IN$ = INKEY$
     IF IN$ = "" GOTO 997

998  REM CONTINUE
     IF UCASE$(IN$) = "P" THEN
       SizeCode$ = " 75"
       LPTNumber = 1
       XLate = -1
       CALL ScrnDump(SizeCode$, LPTNumber, XLate)
       GOTO 9000
     END IF
     IF UCASE$(IN$) = "S" THEN GOTO 8000
GOTO 9000

999  IF TIMER < T0! + HOLD GOTO 996

GOTO 9000

1000  REM TWO-WEIR CASE

'============================================================================
'Setup GPData% Array for Scientific graphs for upstream weir in two-weir case
'============================================================================

CALL SetSpacing(2, 2)
QMAX! = -9999!
QMIN! = 9999!
NCOLS = 0

1100 REM CONTINUE
OPEN "SIDEHYD.PL1" FOR INPUT AS #1
NPTS = 0
FOR I = 1 TO 300
IF EOF(1) GOTO 1200
NPTS = I
INPUT #1, TIME!(I), A1!, A2!, A3!, A4!, QN!(I), A6!, A7!
IF QN!(I) > QMAX! THEN QMAX! = QN!(I)
IF QN!(I) < QMIN! THEN QMIN! = QN!(I)
NEXT I

1200 REM CONTINUE
CLOSE (1)

OPEN "CNTRL1.DAT" FOR INPUT AS #1
LINE INPUT #1, L1$
```

```
LINE INPUT #1, L2$
LINE INPUT #1, L3$
LINE INPUT #1, L4$
LINE INPUT #1, L5$
LINE INPUT #1, L6$
LINE INPUT #1, L7$
LINE INPUT #1, L8$
LINE INPUT #1, L9$
LINE INPUT #1, L10$
LINE INPUT #1, L11$
LINE INPUT #1, L12$
LINE INPUT #1, L13$
LINE INPUT #1, L14$
LINE INPUT #1, L15$
CLOSE (1)
ITSTEP = VAL(MID$(L5$, 16, 2))
ID0 = VAL(MID$(L5$, 19, 2))
IY0 = VAL(MID$(L5$, 24, 2))
IH0 = VAL(MID$(L5$, 27, 2))
IM0 = VAL(MID$(L5$, 29, 2))
ITIME = VAL(MID$(L10$, 16, 3))
JTIME = VAL(MID$(L11$, 16, 3))

1300 REM CONTINUE
OPEN "RETRHYD.OUT" FOR INPUT AS #1

1301 REM CONTINUE
LINE INPUT #1, A$
IF INSTR(A$, "HYDRO") = 2 GOTO 1302
GOTO 1301
1302 REM CONTINUE
IF INSTR(A$, MID$(L14$, 16, LEN(L14$) - 16 + 1)) > 14 GOTO 1305
GOTO 1301

1305 REM CONTINUE
IPTS = 1
RTIME! = -ITSTEP / 60!

1306 REM CONTINUE
IF EOF(1) GOTO 1400
RTIME! = RTIME! + ITSTEP / 60!
LINE INPUT #1, A$
IF ABS(TIME!(IPTS) - RTIME!) > .001 GOTO 1306

QO!(IPTS) = -1! * VAL(MID$(A$, 26, 10))

IF QO!(IPTS) > QMAX! THEN QMAX! = QO!(IPTS)
IF QO!(IPTS) < QMIN! THEN QMIN! = QO!(IPTS)

IPTS = IPTS + 1
GOTO 1306

1400 REM CONTINUE
CLOSE (1)

'======================================================================
'Setup for Scientific graphs - Normal Scientific Graph
```

```
'Upstream Weir for Two-Weir Case
'=======================================================================
REDIM XTitle$(1), YTitle$(2 + 1)    'Dim arrays to hold data for the graphs
REDIM SciData!(NPTS, 2, 2), Colors(2)

MainTitle$ = "U/S Diversion " + MID$(L15$, 16, 3) + "          "

XTitle$(1) = ""

YTitle$(1) = ""

1800  REM DOUBLE GRAPH

REM FIRST GRAPH
Colors(1) = 6
YTitle$(2) = "Assumed"
FOR I = 1 TO NPTS
SciData!(I, 1, 1) = TIME!(I)
SciData!(I, 1, 2) = QO!(I)
NEXT I

REM SECOND GRAPH
Colors(2) = 2
YTitle$(3) = "Computed"
FOR I = 1 TO NPTS
SciData!(I, 2, 1) = TIME!(I)
SciData!(I, 2, 2) = QN!(I)
NEXT I
1900 REM CONTINUE
TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
PointType = 0           '2 means each point plotted is shown as circle

'Draw the normal scientific graph

TMAX! = TIME!(NPTS)
TMIN! = TIME!(1)

MAXYST = 8
YINT!(1) = 1!
YINT!(2) = 2!
YINT!(3) = 2.5
YINT!(4) = 5!
RANGE! = QMAX! - QMIN!

MF! = 1!
1910 REM CONTINUE
FOR I = 1 TO 4
YSTEP! = MF! * YINT!(I)
IF RANGE! / YSTEP! < MAXYST - 1 GOTO 1920
NEXT I
MF! = MF! * 10!
GOTO 1910
1920 REM CONTINUE
QMAXT! = 0
FOR I = 1 TO 10
QMAXT! = QMAXT! + YSTEP!
```

```
IF QMAXT! > QMAX! GOTO 1930
NEXT I
1930 REM CONTINUE
QMAX! = QMAXT!
QMINT! = 0
FOR I = 1 TO 10
QMINT! = QMINT! - YSTEP!
IF QMINT! < QMIN! GOTO 1940
NEXT I
1940 REM CONTINUE
QMIN! = QMINT!
NYSTEP = (QMAX! - QMIN!) / YSTEP! + .0001
GPDat%(5) = INT(TMAX! + 1)              'Maximum value for X axis
GPDat%(6) = INT(TMIN!)                  'Minimum value for X axis
GPDat%(7) = INT(TMAX! + 1) - INT(TMIN!)  'Number of steps for X axis
GPDat%(9) = 0                           'Main Title Color
GPDat%(51) = INT(QMAX!)                 'Maximum value for Y axis
GPDat%(52) = INT(QMIN!)                 'Minimum value for Y axis
GPDat%(53) = NYSTEP                     'Number of steps for Y axis
GPDat%(58) = 0                          'Headings Color
CALL Prepare

GPDat%(37) = 100    'X screen position of the origin
GPDat%(38) = 350    'Y screen position of the origin
GPDat%(39) = 480    'X width of the axis
GPDat%(40) = 290    'Y height of the axis

CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
    Colors(), Xstart, Ystart)

REM Draw the symbols for the upstream weir in the two-weir weir case and
REM then the points for the legend.
Size = 4
FOR I = 1 TO NPTS
  XX! = GPDat%(37) + GPDat%(39) * (SciData!(I, 1, 1) - LowX!) / DiffX!
  YY! = GPDat%(38) - GPDat%(40) * (SciData!(I, 1, 2) - LowY!) / DiffY!
  CIRCLE (XX!, YY!), Size, Colors(1)
  XX! = GPDat%(37) + GPDat%(39) * (SciData!(I, 2, 1) - LowX!) / DiffX!
  YY! = GPDat%(38) - GPDat%(40) * (SciData!(I, 2, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(2), B
NEXT I

XSym = 19
YSym1 = 403
YSym2 = 420
CIRCLE (XSym, YSym1), Size, Colors(1)
LINE (XSym - Size, YSym2 - Size)-(XSym + Size, YSym2 + Size), Colors(2), B

OPEN "SIDEHYD.HS1" FOR INPUT AS #1
LINE INPUT #1, A$
CLOSE (1)

REM WRITE RMSE
x = 460
Y = 300
Colr = 0
CALL DrawText(x, Y, MID$(A$, 3, 15), 0, Colr, TextSize#)
```

```
REM WRITE MERN
x = 460
Y = 320
Colr = 0
CALL DrawText(x, Y, MID$(A$, 23, 15), 0, Colr, TextSize#)

x = 310
Y = 395
Colr = 0
CALL DrawText(x, Y, "TIME    (hrs)", 0, Colr, TextSize#)
x = 10
Y = 230
CALL DrawText(x, Y, "Q       (cfs)", 90, Colr, TextSize#)

REM WRITE FILE NAMES, DATE, AND TIME
x = 105
Y = 7
Colr = 0
TL = LEN(L4$) - 15
CALL DrawText(x, Y, MID$(L4$, 16, TL), 0, Colr, TextSize#)
x = 105
Y = 24
TL = LEN(L6$) - 15
CALL DrawText(x, Y, MID$(L6$, 16, TL), 0, Colr, TextSize#)
x = 105
Y = 41
TL = LEN(L7$) - 15
CALL DrawText(x, Y, MID$(L7$, 16, TL), 0, Colr, TextSize#)
x = 535
Y = 41
CALL DrawText(x, Y, MID$(L2$, 16, 10), 0, Colr, TextSize#)
x = Xstart
Y = 41
CALL DrawText(x, Y, MID$(L3$, 16, 10), 0, Colr, TextSize#)

T0! = TIMER
1996  IN$ = INKEY$
      IF IN$ = "" GOTO 1999

1997  IN$ = INKEY$
      IF IN$ = "" GOTO 1997

1998  REM CONTINUE

    IF UCASE$(IN$) = "P" THEN
       SizeCode$ = " 75"
       LPTNumber = 1
       XLate = -1
       CALL ScrnDump(SizeCode$, LPTNumber, XLate)
       GOTO 2000
     END IF

      GOTO 2000

1999  IF TIMER < T0! + HOLD GOTO 1996
```

```
2000  REM CONTINUE

'=========================================================================
'Setup GPData% Array for Scientific graphs
'=========================================================================

QMAX! = -9999!
QMIN! = 9999!
NCOLS = 0

2100 REM CONTINUE
OPEN "SIDEHYD.PL2" FOR INPUT AS #1
NPTS = 0
FOR I = 1 TO 300
IF EOF(1) GOTO 2200
NPTS = I
INPUT #1, TIME!(I), A1!, A2!, A3!, A4!, QN!(I), A6!, A7!
IF QN!(I) > QMAX! THEN QMAX! = QN!(I)
IF QN!(I) < QMIN! THEN QMIN! = QN!(I)
NEXT I

2200 REM CONTINUE
CLOSE (1)

OPEN "CNTRL2.DAT" FOR INPUT AS #1
LINE INPUT #1, L1$
LINE INPUT #1, L2$
LINE INPUT #1, L3$
LINE INPUT #1, L4$
LINE INPUT #1, L5$
LINE INPUT #1, L6$
LINE INPUT #1, L7$
LINE INPUT #1, L8$
LINE INPUT #1, L9$
LINE INPUT #1, L10$
LINE INPUT #1, L11$
LINE INPUT #1, L12$
LINE INPUT #1, L13$
LINE INPUT #1, L14$
LINE INPUT #1, L15$
CLOSE (1)
ITSTEP = VAL(MID$(L5$, 16, 2))
ID0 = VAL(MID$(L5$, 19, 2))
IY0 = VAL(MID$(L5$, 24, 2))
IH0 = VAL(MID$(L5$, 27, 2))
IM0 = VAL(MID$(L5$, 29, 2))
ITIME = VAL(MID$(L10$, 16, 3))
JTIME = VAL(MID$(L11$, 16, 3))

2300 REM CONTINUE
OPEN "RETRHYD.OUT" FOR INPUT AS #1

2301 REM CONTINUE
LINE INPUT #1, A$
IF INSTR(A$, "HYDRO") = 2 GOTO 2302
GOTO 2301
2302 REM CONTINUE
```

```
IF INSTR(A$, MID$(L14$, 16, LEN(L14$) - 16 + 1)) > 14 GOTO 2305
GOTO 2301

2305 REM CONTINUE
IPTS = 1
RTIME! = -ITSTEP / 60!

2306 REM CONTINUE
IF EOF(1) GOTO 2400
RTIME! = RTIME! + ITSTEP / 60!
LINE INPUT #1, A$
IF ABS(TIME!(IPTS) - RTIME!) > .001 GOTO 2306

QO!(IPTS) = -1! * VAL(MID$(A$, 26, 10))

IF QO!(IPTS) > QMAX! THEN QMAX! = QO!(IPTS)
IF QO!(IPTS) < QMIN! THEN QMIN! = QO!(IPTS)

IPTS = IPTS + 1
GOTO 2306

2400 REM CONTINUE
CLOSE (1)

'==========================================================================
'Setup for Scientific graphs - Normal Scientific Graph
'Downstream Weir for Two-Weir Case
'==========================================================================
REDIM XTitle$(1), YTitle$(2 + 1)    'Dim arrays to hold data for the graphs
REDIM SciData!(NPTS, 2, 2), Colors(2)

MainTitle$ = "D/S Diversion " + MID$(L15$, 16, 3) + "           "

XTitle$(1) = ""

YTitle$(1) = ""

2800  REM DOUBLE GRAPH

REM FIRST GRAPH
Colors(1) = 6
YTitle$(2) = "Assumed"
FOR I = 1 TO NPTS
SciData!(I, 1, 1) = TIME!(I)
SciData!(I, 1, 2) = QO!(I)
NEXT I

REM SECOND GRAPH
Colors(2) = 2
YTitle$(3) = "Computed"
FOR I = 1 TO NPTS
SciData!(I, 2, 1) = TIME!(I)
SciData!(I, 2, 2) = QN!(I)
NEXT I
2900 REM CONTINUE
TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
```

```
PointType = 0           '2 means each point plotted is shown as circle

'Draw the normal scientific graph

TMAX! = TIME!(NPTS)
TMIN! = TIME!(1)

MAXYST = 8
YINT!(1) = 1!
YINT!(2) = 2!
YINT!(3) = 2.5
YINT!(4) = 5!
RANGE! = QMAX! - QMIN!

MF! = 1!
2910 REM CONTINUE
FOR I = 1 TO 4
YSTEP! = MF! * YINT!(I)
IF RANGE! / YSTEP! < MAXYST - 1 GOTO 2920
NEXT I
MF! = MF! * 10!
GOTO 2910
2920 REM CONTINUE
QMAXT! = 0
FOR I = 1 TO 10
QMAXT! = QMAXT! + YSTEP!
IF QMAXT! > QMAX! GOTO 2930
NEXT I
2930 REM CONTINUE
QMAX! = QMAXT!
QMINT! = 0
FOR I = 1 TO 10
QMINT! = QMINT! - YSTEP!
IF QMINT! < QMIN! GOTO 2940
NEXT I
2940 REM CONTINUE
QMIN! = QMINT!
NYSTEP = (QMAX! - QMIN!) / YSTEP! + .0001

GPDat%(5) = INT(TMAX! + 1)                'Maximum value for X axis
GPDat%(6) = INT(TMIN!)                    'Minimum value for X axis
GPDat%(7) = INT(TMAX! + 1) - INT(TMIN!)   'Number of steps for X axis
GPDat%(9) = 0                             'Main Title Color
GPDat%(51) = INT(QMAX!)                   'Maximum value for Y axis
GPDat%(52) = INT(QMIN!)                   'Minimum value for Y axis
GPDat%(53) = NYSTEP                       'Number of steps for Y axis
GPDat%(58) = 0                            'Headings Color
CALL Prepare

GPDat%(37) = 100    'X screen position of the origin
GPDat%(38) = 350    'Y screen position of the origin
GPDat%(39) = 480    'X width of the axis
GPDat%(40) = 290    'Y height of the axis

CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
   Colors(), Xstart, Ystart)
```

```
REM Draw the symbols for the downstream weir in the two-weir weir case and
REM then the points for the legend.
Size = 4
FOR I = 1 TO NPTS
  XX! = GPDat%(37) + GPDat%(39) * (SciData!(I, 1, 1) - LowX!) / DiffX!
  YY! = GPDat%(38) - GPDat%(40) * (SciData!(I, 1, 2) - LowY!) / DiffY!
  CIRCLE (XX!, YY!), Size, Colors(1)
  XX! = GPDat%(37) + GPDat%(39) * (SciData!(I, 2, 1) - LowX!) / DiffX!
  YY! = GPDat%(38) - GPDat%(40) * (SciData!(I, 2, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(2), B
NEXT I

XSym = 19
YSym1 = 403
YSym2 = 420
CIRCLE (XSym, YSym1), Size, Colors(1)
LINE (XSym - Size, YSym2 - Size)-(XSym + Size, YSym2 + Size), Colors(2), B

OPEN "SIDEHYD.HS2" FOR INPUT AS #1
LINE INPUT #1, A$
CLOSE (1)

REM WRITE RMSE
x = 460
Y = 300
Colr = 0
CALL DrawText(x, Y, MID$(A$, 3, 15), 0, Colr, TextSize#)

REM WRITE MERN
x = 460
Y = 320
Colr = 0
CALL DrawText(x, Y, MID$(A$, 23, 15), 0, Colr, TextSize#)

x = 310
Y = 395
Colr = 0
CALL DrawText(x, Y, "TIME    (hrs)", 0, Colr, TextSize#)
x = 10
Y = 230
CALL DrawText(x, Y, "Q       (cfs)", 90, Colr, TextSize#)

REM WRITE FILE NAMES, DATE, AND TIME
x = 105
Y = 7
Colr = 0
TL = LEN(L4$) - 15
CALL DrawText(x, Y, MID$(L4$, 16, TL), 0, Colr, TextSize#)
x = 105
Y = 24
TL = LEN(L6$) - 15
CALL DrawText(x, Y, MID$(L6$, 16, TL), 0, Colr, TextSize#)
x = 105
Y = 41
TL = LEN(L7$) - 15
CALL DrawText(x, Y, MID$(L7$, 16, TL), 0, Colr, TextSize#)
x = 535
```

```
Y = 41
CALL DrawText(x, Y, MID$(L2$, 16, 10), 0, Colr, TextSize#)
x = Xstart
Y = 41
CALL DrawText(x, Y, MID$(L3$, 16, 10), 0, Colr, TextSize#)

T0! = TIMER
2996  IN$ = INKEY$
      IF IN$ = "" GOTO 2999

2997  IN$ = INKEY$
      IF IN$ = "" GOTO 2997

2998  REM CONTINUE

      IF UCASE$(IN$) = "P" THEN
       SizeCode$ = " 75"
       LPTNumber = 1
       XLate = -1
       CALL ScrnDump(SizeCode$, LPTNumber, XLate)
       GOTO 9000
      END IF
      IF UCASE$(IN$) = "S" THEN GOTO 8000

      GOTO 9000

2999  IF TIMER < T0! + HOLD GOTO 2996

GOTO 9000

8000 'CONTINUE

      OPEN "SCRIPT3.BAT" FOR OUTPUT AS #4
      PRINT #4, "C:\H1H2SH\GP3.EXE"
      PRINT #4, "@TYPE MESSAGE.TXT"
      CLOSE (4)

9000  REM CONTINUE

9999  END
```

6.1.13 - MOH1DF.FOR

MOH1DF.FOR is a Fortran program for modifying the HEC-1 input file by incorporating the results of the previous SIDEHYD run. It also checks the stopping criteria and writes the SCRIPT3.BAT file accordingly.

```
C     PROGRAM MOH1DF.FOR
C
C     PURPOSE         : TO MODIFY THE HEC1 INPUT DATA FILE INCORPORATING
C                       THE RESULTS OF THE PREVIOUS SIDEHYD RUN
C                       IF STOPPING CRITERIA NOT MET
C     INVOKED BY      : SCRIPT2.BAT
C     INPUT REQUIRED  : CNTRL.DAT RERNTOL.DAT RETRHYD.OUT SIDEHYD.OUT
C                       <HEC1.DAT>
C     OUTPUT PRODUCED : SIDEHYD.HST SCRIPT3.BAT MOH1DF.OUT
C
C
C
      CHARACTER*50 L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14,L15
      CHARACTER*35 JFILE
      CHARACTER*132 ILINE,JLINE
      CHARACTER*1 KLINE
      CHARACTER*3 MDLR
      CHARACTER*19 ADLR,BDLR
      DIMENSION KLINE(132)
      DIMENSION ADLR(300)
      DIMENSION Q1(300),Q2(300),Q3(300),IQ4(300),IQ5(300)
C
C     OPEN AND READ THE STOP.DAT FILE
C
C
C     OPEN AND READ THE CNTRL.DAT FILE
C
      OPEN(4,FILE='CNTRL.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
10    FORMAT(A50)
11    FORMAT(A80)
C
      CLOSE(4)
```

```
15    FORMAT(A132)
C
C     OPEN THE ERROR TOLERANCE FILE TO READ RERNTOL
C
      OPEN(4,FILE='C:\H1H2SH\RERNTOL.DAT')
      READ(4,16)RERNTOL
      READ(4,16)WEIGHT
      READ(4,16)WEIGHT
16    FORMAT(8X,F10.2)
      CLOSE(4)
C
C     INITIALIZE THE Q ARRAYS
C
      DO 20 I=1,300
      Q1(I)=0.
      Q2(I)=0.
      Q3(I)=0.
      IQ4(I)=0
      IQ5(I)=0
20    CONTINUE
C
C     GET THE FILE NAME OF THE HEC1 BASE DATA FILE
C
      READ(L4,25)JFILE
25    FORMAT(15X,A35)
C
C     READ THE HEC1 TIME DATA
C
      READ(L5,30)ITSTEP,ID0,MDLR,IY0,IH0,IM0
30    FORMAT(15X,I2,1X,I2,A3,I2,1X,I2,I2)
      TSTEP=FLOAT(ITSTEP)/60.
C
C     READ THE ITIME (1ST ORDINATE HYDROGRAPH ABOVE THRESHOLD FLOW)
C
      READ(L10,35)ITIME
35    FORMAT(15X,I3)
C
C     READ THE JTIME (LAST ORDINATE HYDROGRAPH BELOW THRESHOLD FLOW)
C
      READ(L11,35)JTIME
C
C     READ THE STATION NUMBERS UPSTREAM DOWNSTREAM AND AT WEIR
C
      READ(L8,40)IUSTA
      READ(L13,40)IDSTA
      READ(L14,40)IWSTA
40    FORMAT(15X,I15)
C
C     OPEN THE LIST OF HYDROGRAPHS AND SIDEHYD OUTPUT FILES FOR INPUT
C
      OPEN(1,FILE='RETRHYD.OUT')
      OPEN(2,FILE='SIDEHYD.OUT')
C
CJFB  WRITE(*,50)
50    FORMAT(1X,  '******************************',/,
     .       1X,  '* PROGRAM MOH1DF.FOR         *',/,
     .       1X,  '* MODIFY HEC1 IN CARDS       *',/,
```

```
     .       1X,  '* VERSION 05/10/96           *',/,
     .       1X,  '*****************************',/)
C
      CALL GETDAT(IYR,IMO,IDA)
      CALL GETTIM(IHR,IMI,ISE,I100TH)
      WRITE(*,51)IMO,IDA,IYR,IHR,IMI,ISE
51    FORMAT(2H* ,'MOH1DF.FOR      ',I2.2,'/',I2.2,'/',I4.4,
     .              2X,I2.2,':',I2.2,':',I2.2)
C
C     SEARCH FOR THE UPSTREAM STATION IN THE HYDROGRAPH LIST
C
100   CONTINUE
C
C     SKIP THE FIRST LINE IN THE HYDROGRAPH LIST
C
      READ(1,110)KLINE(1)
110   FORMAT(A1)
120   CONTINUE
C
      READ(1,130,END=810)NSTA
130   FORMAT(17X,I6)
      IF(NSTA.EQ.IUSTA)GO TO 150
C
C     OTHERWISE SKIP 300 LINES
C
      DO 140 I=1,300
      READ(1,110)KLINE(1)
140   CONTINUE
C
C     GO BACK TO TRY ANOTHER STATION IN THE HYDROGRAPH LIST
C
      GO TO 120
150   CONTINUE
CJFB  WRITE(*,151)IUSTA
151   FORMAT('  UPWEIR STA: ',I10)
      DO 165 I=1,300
C
C     COPY THE HYDROGRAPH DATA INTO Q1 ARRAY
C
      READ(1,163) ADLR(I),Q1(I)
163   FORMAT(1X,A19,F15.0)
165   CONTINUE
C
C     REWIND THE HYDROGRAPH LIST FILE
C
      REWIND(1)
C
C
C     SEARCH FOR THE ATWEIR STATION IN THE HYDROGRAPH LIST
C
200   CONTINUE
C
C     SKIP THE FIRST LINE
C
      READ(1,210)KLINE(1)
210   FORMAT(A1)
220   CONTINUE
```

```
      READ(1,230,END=820)NSTA
230   FORMAT(17X,I6)
      IF(NSTA.EQ.IWSTA)GO TO 250
C
C     OTHERWISE SKIP 300 LINES
C
      DO 240 I=1,300
      READ(1,210)KLINE(1)
240   CONTINUE
C
C     GO BACK TO TRY ANOTHER STATION IN THE HYDROGRAPH LIST
C
      GO TO 220
250   CONTINUE
CJFB  WRITE(*,251)IWSTA
251   FORMAT('  ATWEIR STA: ',I10)
C
C     COPY THE HYDROGRAPH DATA INTO Q2 ARRAY
C
      DO 265 I=1,300
      READ(1,263) ADLR(I),Q2(I)
263   FORMAT(1X,A19,F15.0)
265   CONTINUE
C
C     FIND THE CALCULATED RESULTS TABLE IN THE SIDEHYD.OUT FILE
C
300   CONTINUE
      RTIM0=FLOAT(IH0)+FLOAT(IM0)/60.
301   CONTINUE
      READ(2,10)ILINE
      IF(INDEX(ILINE,'CALCULATED RESULTS').EQ.2)GO TO 305
      GO TO 301
C
305   CONTINUE
C
C     SKIP SIX LINES
C
      DO 310 J=1,6
      READ(2,110)KLINE(1)
310   CONTINUE
C
      STIME=0.
      Q3C=0.
C
C     LOOP THROUGH ALL ORDINATES OF INTEREST
C
      DO 350 I=ITIME,JTIME
C
319   CONTINUE
C
C     CALCULATE THE REAL TIME (DECIMAL)
C
      RTIME=RTIM0+TSTEP*(I-1)
320   CONTINUE
C
C     FIND THE TIME OF INTEREST IN THE INTERVAL (FOR INTERPOLATION)
C
```

```
      IF(RTIME.GT.STIME)THEN
         READ(2,11,END=330)ILINE
C
C        DISREGARD LINES WITH MESSAGE ERROR OR WARNING
C
         IF(INDEX(ILINE,'MESSAGE').GT.0)GO TO 320
         IF(INDEX(ILINE,'ERROR').GT.0)GO TO 320
         IF(INDEX(ILINE,'WARNING').GT.0)GO TO 320
C
         STIMP=STIME
         Q3P=Q3C
         READ(ILINE,325)STIME,Q3C
325      FORMAT(F8.0,44X,F7.0)
         ENDIF
      IF(RTIME.GT.STIME)GO TO 320
C
C     CALCULATE INTERPOLATED SIDEHYD FLOW AND STORE IN Q3 ARRAY
C
      RATIO=(RTIME-STIMP)/(STIME-STIMP)
      Q3(I)=Q3P+RATIO*(Q3C-Q3P)
      Q3(I)=-1.*Q3(I)
C
CJFB  WRITE(*,326)I,RATIO,RTIME,STIMP,STIME,Q3(I)
326   FORMAT(I10,5F10.3)
      GO TO 350
330   CONTINUE
      Q3(I)=0.
350   CONTINUE
C
C     COMPUTE THE RMSE AND THE RELATIVE ERROR STATISTICS
C
      SUMSQE=0.
      ERRMAX=0.
      QMAX=0.
      DO 370 I=ITIME,JTIME
      ERR=Q3(I)-Q2(I)
      IF(ABS(ERR).GT.ERRMAX)ERRMAX=ABS(ERR)
CERH  IF(ABS(Q3(I)).GT.QMAX)QMAX=ABS(Q3(I))
      IF(ABS(Q2(I)).GT.QMAX)QMAX=ABS(Q2(I))
C     COMPUTE THE AVERAGED FLOW OVER THE WEIR
      IQ4(I)=INT(Q2(I)+WEIGHT*ERR)+0.5
      SUMSQE=SUMSQE+ERR*ERR
CJFB  WRITE(MOH1DF.D01,360)I,Q2(I),Q3(I),IQ4(I)
360   FORMAT(I10,2F12.2,3X,I12)
370   CONTINUE
C
C     WRITE THE ERROR STATISTICS TO THE SIDEHYD.HST FILE
C
      OPEN(3,FILE='SIDEHYD.HST')
      RMS=SQRT(SUMSQE/(JTIME-ITIME+1))
      RERNMAX=ERRMAX/QMAX
      IRMS=INT(RMS+0.5)
      IF(RERNMAX.GT.0.9999)RERNMAX=0.9999
      WRITE(*,375)IRMS,RERNMAX
      WRITE(3,375)IRMS,RERNMAX
375   FORMAT(2X,'RMSE ',I6,' cfs',5X,'MERN     0',F5.4)
C
```

```
C     CLOSE ALL FILES
C
      CLOSE(1)
      CLOSE(2)
      CLOSE(3)
C
C     IF THE MAXIMUM RELATIVE ERROR IS GREATER THAN ERROR TOLERANCE
C     PROCESS AT 380 (WRITE SCRIPT3.BAT TO REITERATE)
C
      IF(RERNMAX.GT.RERNTOL)GO TO 380
C
C     OTHERWISE WRITE SCRIPT3.BAT TO PUT OUT FINAL GRAPH AND STOP
C
      OPEN(4,FILE='SCRIPT3.BAT')
      WRITE(4,377)
377   FORMAT('C:\H1H2SH\GP3.EXE')
      WRITE(4,378)
378   FORMAT('@TYPE MESSAGE.TXT')
      CLOSE(4)
      GO TO 400
C
C     WRITE SCRIPT3.BAT TO REITERATE
C
380   CONTINUE
      OPEN(4,FILE='SCRIPT3.BAT')
C
      WRITE(4,382)
382   FORMAT('HEC1.EXE INPUT=MOH1DF.OUT OUTPUT=HEC1.OUT')
C
383   CONTINUE
      WRITE(4,384)
384   FORMAT('@DEL TAPE23')
      WRITE(4,385)
385   FORMAT('@DEL TAPE24')
      WRITE(4,386)
386   FORMAT('@DEL TAPE25')
      WRITE(4,387)
387   FORMAT('C:\H1H2SH\RETRHYD.EXE')
      WRITE(4,388)
388   FORMAT('C:\H1H2SH\MOH2DF0.EXE')
      WRITE(4,389)
389   FORMAT('C:\H1H2SH\MOH2DF1.EXE')
      WRITE(4,390)
390   FORMAT('C:\H1H2SH\MOH2DF2.EXE')
      WRITE(4,391)
391   FORMAT('C:\H1H2SH\CNTRL.EXE')
      WRITE(4,392)
392   FORMAT('SCRIPT2.BAT')
C
      CLOSE(4)
C
C     COMBINE THE HEC1 BASE DATA FILE FILE AND THE Q ARRAY DATA TO
C     PRODUCE THE NEW HEC1 DATA FILE
C
400   CONTINUE
      DO 405 I=1,300
C
```

```
C     COMPUTE THE FLOW AT DNWEIR STATION
C
      IQ5(I)=INT(Q1(I)+0.5)-IQ4(I)
405   CONTINUE
C
      OPEN(1,FILE=JFILE)
      OPEN(2,FILE='MOH1DF.OUT')
C
C     SEARCH FOR KK DATA SET AT THE DNWEIR STATION
C
410   CONTINUE
      READ(1,15,END=790)ILINE
      IF(INDEX(ILINE,'KK').EQ.1)GO TO 500
      WRITE(2,15)ILINE
      GO TO 410
C
C     HAVING FOUND A KK CARD  CHECK TO SEE IF IT IS THE DNWEIR STATION
C
500   CONTINUE
      READ(ILINE,510,ERR=520)NSTA
510   FORMAT(2X,I6)
      IF(NSTA.EQ.IDSTA)GO TO 600
520   CONTINUE
      WRITE(2,15)ILINE
      GO TO 410
C
C     HAVING FOUND THE DNWEIR KK CARD
C
600   CONTINUE
C
C     FIRST INSERT A NEW KK CARD GROUP FOR THE ATWEIR STATION
C
      WRITE(2,610)IWSTA
610   FORMAT('KK',I6,2X,'ATWEIR HYDROGRAPH')
      WRITE(2,611)
611   FORMAT('BA 0.001')
      WRITE(2,614)ITSTEP,ID0,MDLR,IY0,IH0,IM0
614   FORMAT('IN',I6,1X,I2.2,A3,I2.2,4X,I2.2,I2.2)
      WRITE(2,616)(IQ4(I),I=1,300)
616   FORMAT(('QI',I6,9I8))
      WRITE(2,618)
618   FORMAT('KO     2')
C
C     THEN INSERT THE KK CARD GROUP FOR THE DNWEIR STATION
C
      WRITE(2,620)IDSTA
620   FORMAT('KK',I6,2X,'DNWEIR HYDROGRAPH')
      WRITE(2,622)
622   FORMAT('BA 0.001')
      WRITE(2,614)ITSTEP,ID0,MDLR,IY0,IH0,IM0
      WRITE(2,626)(IQ5(I),I=1,300)
626   FORMAT(('QI',I6,9I8))
      WRITE(2,628)
628   FORMAT('KO     2')
C
C     THEN SEARCH THE BASE DATA FILE FOR THE NEXT KK CARD GROUP
C
```

```
700   CONTINUE
      READ(1,15,END=790)ILINE
      IF(INDEX(ILINE,'KK').EQ.1)GO TO 500
      GO TO 700
C
790   CONTINUE
C
C     CLOSE THE HEC1.DAT BASE DATA FILE AND THE MOH1DF.OUT FILE
C
      CLOSE(1)
      CLOSE(2)
      GO TO 900
C
800   CONTINUE
810   CONTINUE
      WRITE(*,812)
812   FORMAT(1X,'ERROR 812  NO HYDROGRAPH AT UPWEIR')
      GO TO 900
820   CONTINUE
      WRITE(*,822)
822   FORMAT(1X,'ERROR 822  ATWEIR STATION NOT FOUND')
900   CONTINUE
      END
```

6.1.14 - MO2H1DF.FOR

MO2H1DF.FOR is a Fortran pre-processing program to merge the two HEC-1 base data files for the two-weir case.

```
C     PROGRAM MO2H1DF.FOR
C
C     PURPOSE         : TO MERGE THE 2 HEC1 INPUT DATA FILES
C     INVOKED BY      : SCRIPT2.BAT
C     INPUT REQUIRED  : CNTRL2.DAT MOH1DF.OU1 MOH1DF.OU2
C                       C:\H1H2SH\RERNTOL.DAT SIDEHYD.HS1 SIDEHYD.HS2
C     OUTPUT PRODUCED : MOH1DF.OUT SCRIPT3.BAT
C
      CHARACTER*50 L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14,L15
      CHARACTER*132 ILINE
C
C     OPEN AND READ THE CNTRL2.DAT FILE (THE DOWNSTREAM WEIR)
C
      OPEN(4,FILE='CNTRL2.DAT')
      READ(4,10)L1
      READ(4,10)L2
      READ(4,10)L3
      READ(4,10)L4
      READ(4,10)L5
      READ(4,10)L6
      READ(4,10)L7
      READ(4,10)L8
      READ(4,10)L9
      READ(4,10)L10
      READ(4,10)L11
      READ(4,10)L12
      READ(4,10)L13
      READ(4,10)L14
      READ(4,10)L15
10    FORMAT(A50)
11    FORMAT(A80)
C
      CLOSE(4)
15    FORMAT(A132)
16    FORMAT(1X,A132)
C
C     READ THE STATION NUMBERS OF THE DOWNSTREAM AND AT WEIR STATIONS
C
      READ(L13,40)IDSTA
      READ(L14,40)IWSTA
40    FORMAT(15X,I15)
C
CJFB  WRITE(*,50)
50    FORMAT(1X,  '******************************',/,
     .       1X,  '* PROGRAM MO2H1DF.FOR        *',/,
     .       1X,  '* MODIFY HEC1 IN CARDS       *',/,
     .       1X,  '* VERSION 05/10/96           *',/,
     .       1X,  '******************************',/)
C
      CALL GETDAT(IYR,IMO,IDA)
```

```
      CALL GETTIM(IHR,IMI,ISE,I100TH)
      WRITE(*,51)IMO,IDA,IYR,IHR,IMI,ISE
51    FORMAT(2H* ,'MO2H1DF.FOR     ',I2.2,'/',I2.2,'/',I4.4,
     .             2X,I2.2,':',I2.2,':',I2.2)
C
C     OPEN THE ERROR TOLERANCE FILE TO READ RERNTOL
C
      OPEN(1,FILE='C:\H1H2SH\RERNTOL.DAT')
      READ(1,52)RERNTOL
52    FORMAT(8X,F10.2)
      CLOSE(1)
C
C     OPEN THE SIDHYD.HST FILES TO OBTAIN THE ACTUAL ERROR
C
      OPEN(1,FILE='SIDEHYD.HS1')
      READ(1,54)RERNHS1
54    FORMAT(26X,F11.0)
      CLOSE(1)
      OPEN(1,FILE='SIDEHYD.HS2')
      READ(1,54)RERNHS2
C
C     IF THE MAXIMUM RELATIVE ERROR IS LESS THAN ERROR TOLERANCES
C     WRITE SCRIPT3.BAT TO PUT OUT FINAL GRAPHS AND STOP
      IF(RERNHS1.GT.RERNTOL)GO TO 80
      IF(RERNHS2.GT.RERNTOL)GO TO 80
C
C     OTHERWISE WRITE SCRIPT3.BAT TO PUT OUT FINAL GRAPHS AND STOP
C
      OPEN(4,FILE='SCRIPT3.BAT')
      WRITE(4,60)
60    FORMAT('C:\H1H2SH\GP3.EXE')
      WRITE(4,72)
72    FORMAT('@TYPE MESSAGE.TXT')
      CLOSE(4)
      GO TO 900
C
C
80    CONTINUE
C
C     WRITE SCRIPT3.BAT TO REITERATE
C
      OPEN(4,FILE='SCRIPT3.BAT')
      WRITE(4,81)
81    FORMAT('HEC1.EXE INPUT=MOH1DF.OUT OUTPUT=HEC1.OUT')
      WRITE(4,82)
82    FORMAT('@DEL TAPE23')
      WRITE(4,83)
83    FORMAT('@DEL TAPE24')
      WRITE(4,84)
84    FORMAT('@DEL TAPE25')
      WRITE(4,85)
85    FORMAT('C:\H1H2SH\RETRHYD.EXE')
      WRITE(4,86)
86    FORMAT('COPY CNTRL1.DAT CNTRL.DAT')
      WRITE(4,87)
87    FORMAT('C:\H1H2SH\MOH2DFK.EXE')
      WRITE(4,88)
```

```
88    FORMAT('C:\H1H2SH\MOH2DF1.EXE')
      WRITE(4,89)
89    FORMAT('C:\H1H2SH\MOH2DF2.EXE')
      WRITE(4,90)
90    FORMAT('COPY CNTRL.DAT CNTRL1.DAT')
      WRITE(4,91)
91    FORMAT('C:\H1H2SH\KCNTRL.EXE')
      WRITE(4,92)
92    FORMAT('SCRIPT2.BAT')
C
      CLOSE(4)

C
C     OPEN THE TWO MOH1DF.OUT FILES FOR INPUT
C
      OPEN(1,FILE='MOH1DF.OU1')
      OPEN(2,FILE='MOH1DF.OU2')
      OPEN(3,FILE='MOH1DF.OUT')

C
C     READ AND COPY THE FIRST FILE SEARCHING FOR THE 2ND WEIR DNWEIR STATION
C
100   CONTINUE
C
      READ(1,15,END=800)ILINE
      IF(INDEX(ILINE,'KK').EQ.1)GO TO 200
      WRITE(3,15)ILINE
      GO TO 100
C
200   CONTINUE
      READ(ILINE,210,ERR=220)NSTA
210   FORMAT(2X,I6)
      IF(NSTA.EQ.IDSTA)GO TO 300
220   CONTINUE
      WRITE(3,15)ILINE
      GO TO 100
C
C     READ AND SKIP IN THE 2ND FILE UNTIL THE ATWEIR STATION
C
300   CONTINUE
      READ(2,15,END=800)ILINE
      IF(INDEX(ILINE,'KK').EQ.1)GO TO 400
      GO TO 300
400   CONTINUE
      READ(ILINE,410,ERR=300)NSTA
410   FORMAT(2X,I6)
      IF(NSTA.EQ.IWSTA)GO TO 500
      GO TO 300
500   CONTINUE
      WRITE(3,15)ILINE
600   CONTINUE
      READ(2,15,END=800)ILINE
      WRITE(3,15)ILINE
      GO TO 600
800   CONTINUE
      CLOSE(1)
      CLOSE(2)
```

```
      CLOSE(3)
900   CONTINUE
      END
```

6.1.15 - GP3.BAS

GP3.BAS is a of a Basic language graphics program. This program produces a graphics display of the complete operation of the weir. The program is called as the final step in the procedure. The program is a compiled Basic program using GraphPack Professional library and subroutine calls (Crescent Software, undated). Some of the GraphPak subroutines were customized for SAS applications.

```
DECLARE SUB SetColors (ForeGround%, BackGround%, Headings%, ZeroAxis%)
REM    GP3.BAS  TWO GRAPHS ON THE SCREEN
REM    INPUT REQUIRED: CNTRL.DAT (CNTRL1.DAT & CNTRL2.DAT FOR 2 WEIR)
REM                    SIDEHYD.PLT (SIDEHYD.PL1 & SIDEHYD.PL2 FOR 2 WEIR)
REM
REM    OUTPUT PRODUCED: SCREEN GRAPHIC AND (OPTIONAL) PRINTER GRAPHIC
REM
DEFINT A-Z
DIM TIME!(300), HD!(300), QD!(300), HU!(300), QU!(300), QW!(300), HP!(300)

'These DECLARE statements are for QuickBASIC 4.0

DECLARE SUB GPPause ()
DECLARE SUB Prepare ()
DECLARE SUB SetSpacing (SpacingH%, SpacingV%)
DECLARE SUB SetFont (FontNumber%)
DECLARE SUB LineSci (SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType,
   PointType, Colors(), Xstart, Ystart)
DECLARE SUB DrawText (XX%, YY%, Text$, Angle%, Colr%, TextSize#)
DECLARE SUB BoxText (Text$, Colr, X, Y, J, T, FS)
DECLARE SUB SetVideo ()
DECLARE FUNCTION GetTextWidth% (Text$)
DECLARE SUB LoadFont (FontFile$)
DECLARE FUNCTION HercThere%
DECLARE SUB GPExist (FileName$, There)

'==========================================================================
'Setup Screen, Fonts, Tiles, ...
'==========================================================================
'$INCLUDE: 'Simpl1'

CALL SetVideo                   'initiate graphics using the correct Screen

Ystart = 1
QLABEL$ = "Plotted Qs are actual Qs divided by 10."
XQ = 32
YQ = 205
REM Set background to white, axes to black
CALL SetColors(0, 15, 4, 0)
CALL GPExist("SIDEHYD.PLT", There)
IF NOT There GOTO 2000

'==========================================================================
'Setup GPData% Array for Scientific graphs
'==========================================================================
```

```
CALL SetSpacing(2, 2)
FontFile$ = "C:\H1H2SH\Helv8"
CALL SetFont(2)
CALL LoadFont(FontFile$)

OPEN "CNTRL.DAT" FOR INPUT AS #1
LINE INPUT #1, L1$
LINE INPUT #1, L2$
LINE INPUT #1, L3$
LINE INPUT #1, L4$
LINE INPUT #1, L5$
LINE INPUT #1, L6$
LINE INPUT #1, L7$
LINE INPUT #1, L8$
LINE INPUT #1, L9$
LINE INPUT #1, L10$
LINE INPUT #1, L11$
LINE INPUT #1, L12$
LINE INPUT #1, L13$
LINE INPUT #1, L14$
LINE INPUT #1, L15$
CLOSE (1)

OPEN "SIDEHYD.PLT" FOR INPUT AS #1
QMAX! = -99999!
QMIN! = 99999!
HMAX! = -99999!
HMIN! = 99999!
NPTS = 0
FOR I = 1 TO 300
  IF EOF(1) GOTO 100
  NPTS = I
  INPUT #1, TIME!(I), HD!(I), QD!(I), HU!(I), QU!(I), QW!(I), HP!(I), WHT
  IF QU!(I) > QMAX! THEN QMAX! = QU!(I)
  IF QD!(I) > QMAX! THEN QMAX! = QD!(I)
  IF QW!(I) > QMAX! THEN QMAX! = QW!(I)
  IF QU!(I) < QMIN! THEN QMIN! = QU!(I)
  IF QD!(I) < QMIN! THEN QMIN! = QD!(I)
  IF QW!(I) < QMIN! THEN QMIN! = QW!(I)
  IF HU!(I) > HMAX! THEN HMAX! = HU!(I)
  IF HD!(I) > HMAX! THEN HMAX! = HD!(I)
  IF HP!(I) > HMAX! THEN HMAX! = HP!(I)
  IF HU!(I) < HMIN! THEN HMIN! = HU!(I)
  IF HD!(I) < HMIN! THEN HMIN! = HD!(I)
  IF HP!(I) < HMIN! THEN HMIN! = HP!(I)
NEXT I

100 REM CONTINUE

CLOSE #1

ISCALE% = 0
IF QMAX! > 30000 OR QMIN! < -30000 THEN
  ISCALE% = 1
  FOR I = 1 TO NPTS
    QU!(I) = .1 * QU!(I)
    QD!(I) = .1 * QD!(I)
```

```
    QW!(I) = .1 * QW!(I)
  NEXT I
  QMAX! = .1 * QMAX!
  QMIN! = .1 * QMIN!
END IF

'==========================================================================
'Setup for Normal Scientific Graph for One Weir Case
'==========================================================================
REDIM XTitle$(1), YTitle$(4)      'Dim arrays to hold data for the graphs
REDIM SciData!(NPTS, 3, 2), Colors(3)

MainTitle$ = "One Diversion        "        'underscore forces a line break

XTitle$(1) = ""

YTitle$(1) = ""
YTitle$(2) = "UPSTREAM"
YTitle$(3) = "POND"
YTitle$(4) = "DNSTREAM"

Colors(1) = 1           'Blue
Colors(2) = 2           'Green
Colors(3) = 4           'Red

FOR I = 1 TO NPTS
  SciData!(I, 1, 1) = TIME!(I)
  SciData!(I, 1, 2) = QU!(I)
  SciData!(I, 2, 1) = TIME!(I)
  SciData!(I, 2, 2) = QW!(I)
  SciData!(I, 3, 1) = TIME!(I)
  SciData!(I, 3, 2) = QD!(I)
NEXT I

TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
PointType = 0           '0 = none, 1 = square, 2 = circle, 3 = a

'Draw the normal scientific graph

TMAX! = TIME!(NPTS)
TMIN! = TIME!(1)

MAXYST = 7
YINT!(1) = 1!
YINT!(2) = 2!
YINT!(3) = 2.5
YINT!(4) = 5!
RANGE! = QMAX! - QMIN!
MF! = 1!
910 REM CONTINUE

FOR I = 1 TO 4
  YSTEP! = MF! * YINT!(I)
  IF RANGE! / YSTEP! < MAXYST - 1 GOTO 920
NEXT I
```

```
MF! = MF! * 10!
GOTO 910
920 REM CONTINUE
QMAXT! = 0
FOR I = 1 TO 10
  QMAXT! = QMAXT! + YSTEP!
  IF QMAXT! > QMAX! GOTO 930
NEXT I

930 REM CONTINUE
QMAX! = QMAXT!
QMINT! = 0

FOR I = 1 TO 10
  QMINT! = QMINT! - YSTEP!
  IF QMINT! < QMIN! GOTO 940
NEXT I

940 REM CONTINUE
QMIN! = QMINT!
NYSTEP = (QMAX! - QMIN!) / YSTEP! + .0001
GPDAT%(1) = -1
GPDAT%(5) = INT(TMAX! + 1)              'Maximum value for X axis
GPDAT%(6) = INT(TMIN!)                  'Minimum value for X axis
GPDAT%(7) = INT(TMAX! + 1) - INT(TMIN!)  'Number of steps for X axis
GPDAT%(9) = 0                           'Main Title Color
GPDAT%(51) = INT(QMAX!)                 'Maximum value for Y axis
GPDAT%(52) = INT(QMIN! + .0001)         'Minimum value for Y axis
GPDAT%(53) = NYSTEP                     'Number of steps for Y axis
GPDAT%(58) = 0                          'Headings Color

CALL Prepare

IF GPDAT%(31) <> 8 GOTO 9000

GPDAT%(37) = 100    'X screen position of the origin
GPDAT%(38) = 210    'Y screen position of the origin
GPDAT%(39) = 480    'X width of the axis
GPDAT%(40) = 180    'Y height of the axis

CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
   Colors(), Xstart, Ystart)

Size = 4
FOR I = 1 TO NPTS
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 1, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 1, 2) - LowY!) / DiffY!
  CIRCLE (XX!, YY!), Size, Colors(1)
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 2, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 2, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(2), B
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 3, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 3, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(3)
  LINE (XX! + Size, YY! - Size)-(XX! - Size, YY! + Size), Colors(3)
NEXT I
```

```
Size = 3
XSym = 19
YSym1 = 246
YSym2 = 256
YSym3 = 266
CIRCLE (XSym, YSym1), Size, Colors(1)
LINE (XSym - Size, YSym2 - Size)-(XSym + Size, YSym2 + Size), Colors(2), B
LINE (XSym - Size, YSym3 - Size)-(XSym + Size, YSym3 + Size), Colors(3)
LINE (XSym + Size, YSym3 - Size)-(XSym - Size, YSym3 + Size), Colors(3)

X = 310
Y = 245
Colr = 0
CALL DrawText(X, Y, "TIME    (hrs)", 0, Colr, TextSize#)

X = 20
Y = 140
CALL DrawText(X, Y, "Q       (cfs)", 90, Colr, TextSize#)
IF ISCALE% = 1 THEN CALL DrawText(XQ, YQ, QLABEL$, 90, Colr, TextSize#)

'==========================================================================
'Setup for SECOND graph - WEIRCREST Elevation
'==========================================================================
REDIM XTitle$(1), YTitle$(2)      'Dim arrays to hold data for the graphs
REDIM SciData!(2, 1, 2), Colors(1)

MainTitle$ = ""
XTitle$(1) = ""
YTitle$(1) = ""
YTitle$(2) = ""

Colors(1) = 0

SciData!(1, 1, 1) = INT(TMIN!)
SciData!(1, 1, 2) = WHT
SciData!(2, 1, 1) = INT(TMAX! + 1)
SciData!(2, 1, 2) = WHT

TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
PointType = 0           '0 = none, 1 = square, 2 = circle, 3 = a

'Draw the normal scientific graph

TMAX! = TIME!(NPTS)
TMIN! = TIME!(1)

MAXYST = 7
YINT!(1) = 1!
YINT!(2) = 2!
YINT!(3) = 2.5
YINT!(4) = 5!



RANGE! = HMAX! - HMIN!
```

```
MF! = 1!
1910 REM CONTINUE

FOR I = 1 TO 4
  YSTEP! = MF! * YINT!(I)
  IF RANGE! / YSTEP! < MAXYST - 1 GOTO 1920
NEXT I

MF! = MF! * 10!
GOTO 1910
1920 REM CONTINUE
HMAXT! = 0
1921 REM CONTINUE
HMAXT! = HMAXT! + YSTEP!
IF HMAXT! > HMAX! GOTO 1930
GOTO 1921
1930 REM CONTINUE
HMAX! = HMAXT!
HMINT! = HMAX!

FOR I = 1 TO 10
  HMINT! = HMINT! - YSTEP!
  IF HMINT! < HMIN! GOTO 1940
NEXT I

1940 REM CONTINUE
HMIN! = HMINT!

NYSTEP = (HMAX! - HMIN!) / YSTEP! + .0001

GPDAT%(1) = 0                          'Turns off all labels
GPDAT%(5) = INT(TMAX! + 1)             'Maximum value for X axis
GPDAT%(6) = INT(TMIN!)                 'Minimum value for X axis
GPDAT%(7) = INT(TMAX! + 1) - INT(TMIN!)  'Number of steps for X axis
GPDAT%(12) = 0                         'Turns off Main Title
GPDAT%(51) = INT(HMAX!)                'Maximum value for Y axis
GPDAT%(52) = INT(HMIN! + .0001)        'Minimum value for Y axis
GPDAT%(53) = NYSTEP                    'Number of steps for Y axis
GPDAT%(58) = 0                         'Headings Color

GPDAT%(37) = 100    'X screen position of the origin
GPDAT%(38) = 430    'Y screen position of the origin
GPDAT%(39) = 480    'X width of the axis
GPDAT%(40) = 150    'Y height of the axis

CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
   Colors(), Xstart, Ystart)

'==========================================================================
'Setup for THIRD graph - Normal Scientific Graph
'==========================================================================
REDIM XTitle$(1), YTitle$(4)      'Dim arrays to hold data for the graphs
REDIM SciData!(NPTS, 3, 2), Colors(3)

MainTitle$ = ""              'underscore forces a line break

XTitle$(1) = ""      'the first title is the X axis heading
```

```
YTitle$(1) = ""
YTitle$(2) = "UPSTREAM"
YTitle$(3) = "POND"
YTitle$(4) = "DNSTREAM"

Colors(1) = 1           'Blue
Colors(2) = 2           'Green
Colors(3) = 4           'Red

FOR I = 1 TO NPTS
  SciData!(I, 1, 1) = TIME!(I)
  SciData!(I, 1, 2) = HU!(I)
  SciData!(I, 2, 1) = TIME!(I)
  SciData!(I, 2, 2) = HP!(I)
  SciData!(I, 3, 1) = TIME!(I)
  SciData!(I, 3, 2) = HD!(I)
NEXT I

TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
PointType = 0           '0 = none, 1 = square, 2 = circle, 3 = a

'Draw the normal scientific graph

GPDAT%(1) = 1                           'Turns on Axis Headings, Off Legend
GPDAT%(12) = -1                         'Turns on Main Title

GPDAT%(37) = 100    'X screen position of the origin
GPDAT%(38) = 430    'Y screen position of the origin
GPDAT%(39) = 480    'X width of the axis
GPDAT%(40) = 150    'Y height of the axis

CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
    Colors(), Xstart, Ystart)

Size = 4
FOR I = 1 TO NPTS
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 1, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 1, 2) - LowY!) / DiffY!
  CIRCLE (XX!, YY!), Size, Colors(1)
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 2, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 2, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(2), B
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 3, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 3, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(3)
  LINE (XX! + Size, YY! - Size)-(XX! - Size, YY! + Size), Colors(3)
NEXT I

Size = 3
XSym = 19
YSym1 = 246
YSym2 = 256
YSym3 = 266
CIRCLE (XSym, YSym1), Size, Colors(1)
LINE (XSym - Size, YSym2 - Size)-(XSym + Size, YSym2 + Size), Colors(2), B
```

```
LINE (XSym - Size, YSym3 - Size)-(XSym + Size, YSym3 + Size), Colors(3)
LINE (XSym + Size, YSym3 - Size)-(XSym - Size, YSym3 + Size), Colors(3)

X = 310
Y = 465
Colr = 0
CALL DrawText(X, Y, "TIME    (hrs)", 0, Colr, TextSize#)
X = 20
Y = 375
CALL DrawText(X, Y, "Elev       (ft)", 90, Colr, TextSize#)

X = 105
Y = 2
Colr = 0
TL = LEN(L4$) - 15
CALL DrawText(X, Y, MID$(L4$, 16, TL), 0, Colr, TextSize#)

X = 105
Y = 11
TL = LEN(L6$) - 15
CALL DrawText(X, Y, MID$(L6$, 16, TL), 0, Colr, TextSize#)

X = 105
Y = 20
TL = LEN(L7$) - 15
CALL DrawText(X, Y, MID$(L7$, 16, TL), 0, Colr, TextSize#)

X = 545
Y = 20
CALL DrawText(X, Y, MID$(L2$, 16, 10), 0, Colr, TextSize#)

X = Xstart
Y = 20
CALL DrawText(X, Y, MID$(L3$, 16, 10), 0, Colr, TextSize#)

1996 REM CONTINUE
1997 IF INKEY$ = "" GOTO 1996

       IF UCASE$(INKEY$) = "P" THEN
     SizeCode$ = " 75"
     LPTNumber = 1
     XLate = -1
     CALL ScrnDump(SizeCode$, LPTNumber, XLate)
     GOTO 9000
       END IF

GOTO 9000

2000 REM CONTINUE

'==========================================================================
'Setup GPData% Array for Scientific graphs
'==========================================================================
CALL SetSpacing(2, 2)
FontFile$ = "C:\H1H2SH\Helv8"
CALL SetFont(2)
CALL LoadFont(FontFile$)
```

```
OPEN "CNTRL1.DAT" FOR INPUT AS #1
LINE INPUT #1, L1$
LINE INPUT #1, L2$
LINE INPUT #1, L3$
LINE INPUT #1, L4$
LINE INPUT #1, L5$
LINE INPUT #1, L6$
LINE INPUT #1, L7$
LINE INPUT #1, L8$
LINE INPUT #1, L9$
LINE INPUT #1, L10$
LINE INPUT #1, L11$
LINE INPUT #1, L12$
LINE INPUT #1, L13$
LINE INPUT #1, L14$
LINE INPUT #1, L15$
CLOSE (1)

OPEN "SIDEHYD.PL1" FOR INPUT AS #1
QMAX! = -99999!
QMIN! = 99999!
HMAX! = -99999!
HMIN! = 99999!
NPTS = 0
FOR I = 1 TO 300
  IF EOF(1) GOTO 2100
  NPTS = I
  INPUT #1, TIME!(I), HD!(I), QD!(I), HU!(I), QU!(I), QW!(I), HP!(I), WHT
  IF QU!(I) > QMAX! THEN QMAX! = QU!(I)
  IF QD!(I) > QMAX! THEN QMAX! = QD!(I)
  IF QW!(I) > QMAX! THEN QMAX! = QW!(I)
  IF QU!(I) < QMIN! THEN QMIN! = QU!(I)
  IF QD!(I) < QMIN! THEN QMIN! = QD!(I)
  IF QW!(I) < QMIN! THEN QMIN! = QW!(I)
  IF HU!(I) > HMAX! THEN HMAX! = HU!(I)
  IF HD!(I) > HMAX! THEN HMAX! = HD!(I)
  IF HP!(I) > HMAX! THEN HMAX! = HP!(I)
  IF HU!(I) < HMIN! THEN HMIN! = HU!(I)
  IF HD!(I) < HMIN! THEN HMIN! = HD!(I)
  IF HP!(I) < HMIN! THEN HMIN! = HP!(I)
NEXT I

2100 REM CONTINUE

CLOSE #1

ISCALE% = 0
IF QMAX! > 30000 OR QMIN! < -30000 THEN
  ISCALE% = 1
  FOR I = 1 TO NPTS
    QU!(I) = .1 * QU!(I)
    QD!(I) = .1 * QD!(I)
    QW!(I) = .1 * QW!(I)
  NEXT I
  QMAX! = .1 * QMAX!
  QMIN! = .1 * QMIN!
```

```
END IF

'=====================================================================
'Setup for Normal Scientific Graph for Upstream Weir (2 Weir Case)
'=====================================================================
REDIM XTitle$(1), YTitle$(4)      'Dim arrays to hold data for the graphs
REDIM SciData!(NPTS, 3, 2), Colors(3)

MainTitle$ = "U/S Diversion        "       'underscore forces a line break

XTitle$(1) = ""

YTitle$(1) = ""
YTitle$(2) = "UPSTREAM"
YTitle$(3) = "POND"
YTitle$(4) = "DNSTREAM"

Colors(1) = 1           'Blue
Colors(2) = 2           'Green
Colors(3) = 4           'Red

FOR I = 1 TO NPTS

  SciData!(I, 1, 1) = TIME!(I)
  SciData!(I, 1, 2) = QU!(I)
  SciData!(I, 2, 1) = TIME!(I)
  SciData!(I, 2, 2) = QW!(I)
  SciData!(I, 3, 1) = TIME!(I)
  SciData!(I, 3, 2) = QD!(I)

NEXT I

TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
PointType = 0           '0 = none, 1 = square, 2 = circle, 3 = a

'Draw the normal scientific graph

TMAX! = TIME!(NPTS)
TMIN! = TIME!(1)

MAXYST = 7
YINT!(1) = 1!
YINT!(2) = 2!
YINT!(3) = 2.5
YINT!(4) = 5!
RANGE! = QMAX! - QMIN!

MF! = 1!
2910 REM CONTINUE
FOR I = 1 TO 4
YSTEP! = MF! * YINT!(I)
IF RANGE! / YSTEP! < MAXYST - 1 GOTO 2920
NEXT I
MF! = MF! * 10!
GOTO 2910
2920 REM CONTINUE
```

```
QMAXT! = 0
FOR I = 1 TO 10
QMAXT! = QMAXT! + YSTEP!
IF QMAXT! > QMAX! GOTO 2930
NEXT I
2930 REM CONTINUE
QMAX! = QMAXT!
QMINT! = 0
FOR I = 1 TO 10
QMINT! = QMINT! - YSTEP!
IF QMINT! < QMIN! GOTO 2940
NEXT I
2940 REM CONTINUE
QMIN! = QMINT!
NYSTEP = (QMAX! - QMIN!) / YSTEP! + .0001

GPDAT%(1) = -1
GPDAT%(5) = INT(TMAX! + 1)              'Maximum value for X axis
GPDAT%(6) = INT(TMIN!)                  'Minimum value for X axis
GPDAT%(7) = INT(TMAX! + 1) - INT(TMIN!)  'Number of steps for X axis
GPDAT%(9) = 0                           'Main Title Color
GPDAT%(51) = INT(QMAX!)                 'Maximum value for Y axis
GPDAT%(52) = INT(QMIN! + .0001)         'Minimum value for Y axis
GPDAT%(53) = NYSTEP                     'Number of steps for Y axis
GPDAT%(58) = 0                          'Headings Color
CALL Prepare

IF GPDAT%(31) <> 8 GOTO 9000

GPDAT%(37) = 100    'X screen position of the origin
GPDAT%(38) = 210    'Y screen position of the origin
GPDAT%(39) = 480    'X width of the axis
GPDAT%(40) = 180    'Y height of the axis

CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
   Colors(), Xstart, Ystart)

Size = 4
FOR I = 1 TO NPTS
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 1, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 1, 2) - LowY!) / DiffY!
  CIRCLE (XX!, YY!), Size, Colors(1)
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 2, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 2, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(2), B
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 3, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 3, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(3)
  LINE (XX! + Size, YY! - Size)-(XX! - Size, YY! + Size), Colors(3)
NEXT I

Size = 3
XSym = 19
YSym1 = 246
YSym2 = 256
YSym3 = 266
CIRCLE (XSym, YSym1), Size, Colors(1)
```

```
LINE (XSym - Size, YSym2 - Size)-(XSym + Size, YSym2 + Size), Colors(2), B
LINE (XSym - Size, YSym3 - Size)-(XSym + Size, YSym3 + Size), Colors(3)
LINE (XSym + Size, YSym3 - Size)-(XSym - Size, YSym3 + Size), Colors(3)

X = 310
Y = 245
Colr = 0
CALL DrawText(X, Y, "TIME    (hrs)", 0, Colr, TextSize#)
X = 20
Y = 140
CALL DrawText(X, Y, "Q       (cfs)", 90, Colr, TextSize#)
IF ISCALE% = 1 THEN CALL DrawText(XQ, YQ, QLABEL$, 90, Colr, TextSize#)

'==========================================================================
'Setup for SECOND graph - WEIRCREST Elevation
'==========================================================================
REDIM XTitle$(1), YTitle$(2)      'Dim arrays to hold data for the graphs
REDIM SciData!(2, 1, 2), Colors(1)

MainTitle$ = ""
XTitle$(1) = ""
YTitle$(1) = ""
YTitle$(2) = ""

Colors(1) = 0

SciData!(1, 1, 1) = INT(TMIN!)
SciData!(1, 1, 2) = WHT
SciData!(2, 1, 1) = INT(TMAX! + 1)
SciData!(2, 1, 2) = WHT

TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
PointType = 0           '0 = none, 1 = square, 2 = circle, 3 = a

'Draw the normal scientific graph

TMAX! = TIME!(NPTS)
TMIN! = TIME!(1)

MAXYST = 7
YINT!(1) = 1!
YINT!(2) = 2!
YINT!(3) = 2.5
YINT!(4) = 5!
RANGE! = HMAX! - HMIN!

MF! = 1!
3910 REM CONTINUE
FOR I = 1 TO 4
YSTEP! = MF! * YINT!(I)
IF RANGE! / YSTEP! < MAXYST - 1 GOTO 3920
NEXT I
MF! = MF! * 10!
GOTO 3910
3920 REM CONTINUE
HMAXT! = 0
```

```
3921 REM CONTINUE
HMAXT! = HMAXT! + YSTEP!
IF HMAXT! > HMAX! GOTO 3930
GOTO 3921
3930 REM CONTINUE
HMAX! = HMAXT!
HMINT! = HMAX!
FOR I = 1 TO 10
HMINT! = HMINT! - YSTEP!
IF HMINT! < HMIN! GOTO 3940
NEXT I
3940 REM CONTINUE
HMIN! = HMINT!

NYSTEP = (HMAX! - HMIN!) / YSTEP! + .0001

GPDAT%(1) = 0                          'Turns off all labels
GPDAT%(5) = INT(TMAX! + 1)             'Maximum value for X axis
GPDAT%(6) = INT(TMIN!)                 'Minimum value for X axis
GPDAT%(7) = INT(TMAX! + 1) - INT(TMIN!)  'Number of steps for X axis
GPDAT%(12) = 0                         'Turns off Main Title
GPDAT%(51) = INT(HMAX!)                'Maximum value for Y axis
GPDAT%(52) = INT(HMIN! + .0001)        'Minimum value for Y axis
GPDAT%(53) = NYSTEP                    'Number of steps for Y axis
GPDAT%(58) = 0                         'Headings Color

GPDAT%(37) = 100    'X screen position of the origin
GPDAT%(38) = 430    'Y screen position of the origin
GPDAT%(39) = 480    'X width of the axis
GPDAT%(40) = 150    'Y height of the axis

CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
   Colors(), Xstart, Ystart)

'==========================================================================
'Setup for THIRD graph - Normal Scientific Graph
'==========================================================================
REDIM XTitle$(1), YTitle$(4)      'Dim arrays to hold data for the graphs
REDIM SciData!(NPTS, 3, 2), Colors(3)

MainTitle$ = ""              'underscore forces a line break

XTitle$(1) = ""      'the first title is the X axis heading

YTitle$(1) = ""
YTitle$(2) = "UPSTREAM"
YTitle$(3) = "POND"
YTitle$(4) = "DNSTREAM"

Colors(1) = 1           'Blue
Colors(2) = 2           'Green
Colors(3) = 4           'Red

FOR I = 1 TO NPTS

  SciData!(I, 1, 1) = TIME!(I)
  SciData!(I, 1, 2) = HU!(I)
```

```
  SciData!(I, 2, 1) = TIME!(I)
  SciData!(I, 2, 2) = HP!(I)
  SciData!(I, 3, 1) = TIME!(I)
  SciData!(I, 3, 2) = HD!(I)

NEXT I

TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
PointType = 0           '0 = none, 1 = square, 2 = circle, 3 = a

'Draw the normal scientific graph

GPDAT%(1) = 1                        'Turns on Axis Headings, Off Legend
GPDAT%(12) = -1                      'Turns on Main Title

GPDAT%(37) = 100    'X screen position of the origin
GPDAT%(38) = 430    'Y screen position of the origin
GPDAT%(39) = 480    'X width of the axis
GPDAT%(40) = 150    'Y height of the axis

CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
   Colors(), Xstart, Ystart)

Size = 4
FOR I = 1 TO NPTS
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 1, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 1, 2) - LowY!) / DiffY!
  CIRCLE (XX!, YY!), Size, Colors(1)
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 2, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 2, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(2), B
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 3, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 3, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(3)
  LINE (XX! + Size, YY! - Size)-(XX! - Size, YY! + Size), Colors(3)
NEXT I

X = 310
Y = 465
Colr = 0
CALL DrawText(X, Y, "TIME    (hrs)", 0, Colr, TextSize#)
X = 20
Y = 375
CALL DrawText(X, Y, "Elev       (ft)", 90, Colr, TextSize#)

X = 105
Y = 2
Colr = 0
TL = LEN(L4$) - 15
CALL DrawText(X, Y, MID$(L4$, 16, TL), 0, Colr, TextSize#)
X = 105
Y = 11
TL = LEN(L6$) - 15
CALL DrawText(X, Y, MID$(L6$, 16, TL), 0, Colr, TextSize#)
X = 105
Y = 20
```

```
TL = LEN(L7$) - 15
CALL DrawText(X, Y, MID$(L7$, 16, TL), 0, Colr, TextSize#)
X = 545
Y = 20
CALL DrawText(X, Y, MID$(L2$, 16, 10), 0, Colr, TextSize#)
X = Xstart
Y = 20
CALL DrawText(X, Y, MID$(L3$, 16, 10), 0, Colr, TextSize#)

X = 105
Y = 2
Colr = 0
TL = LEN(L4$) - 15
CALL DrawText(X, Y, MID$(L4$, 16, TL), 0, Colr, TextSize#)
X = 105
Y = 11
TL = LEN(L6$) - 15
CALL DrawText(X, Y, MID$(L6$, 16, TL), 0, Colr, TextSize#)
X = 105
Y = 20
TL = LEN(L7$) - 15
CALL DrawText(X, Y, MID$(L7$, 16, TL), 0, Colr, TextSize#)
X = 545
Y = 20
CALL DrawText(X, Y, MID$(L2$, 16, 10), 0, Colr, TextSize#)
X = Xstart
Y = 20
CALL DrawText(X, Y, MID$(L3$, 16, 10), 0, Colr, TextSize#)

3996 REM CONTINUE
3997 IF INKEY$ = "" GOTO 3996

      IF UCASE$(INKEY$) = "P" THEN
    SizeCode$ = " 75"
    LPTNumber = 1
    XLate = -1
    CALL ScrnDump(SizeCode$, LPTNumber, XLate)
    GOTO 4000
      END IF

4000 REM CONTINUE

'=========================================================================
'Setup GPData% Array for Scientific graphs
'=========================================================================
CALL SetSpacing(2, 2)

OPEN "CNTRL2.DAT" FOR INPUT AS #1
LINE INPUT #1, L1$
LINE INPUT #1, L2$
LINE INPUT #1, L3$
LINE INPUT #1, L4$
LINE INPUT #1, L5$
LINE INPUT #1, L6$
LINE INPUT #1, L7$
LINE INPUT #1, L8$
LINE INPUT #1, L9$
```

```
LINE INPUT #1, L10$
LINE INPUT #1, L11$
LINE INPUT #1, L12$
LINE INPUT #1, L13$
LINE INPUT #1, L14$
LINE INPUT #1, L15$
CLOSE (1)

OPEN "SIDEHYD.PL2" FOR INPUT AS #1
QMAX! = -99999!
QMIN! = 99999!
HMAX! = -99999!
HMIN! = 99999!
NPTS = 0
FOR I = 1 TO 300
  IF EOF(1) GOTO 4100
  NPTS = I
  INPUT #1, TIME!(I), HD!(I), QD!(I), HU!(I), QU!(I), QW!(I), HP!(I), WHT
  IF QU!(I) > QMAX! THEN QMAX! = QU!(I)
  IF QD!(I) > QMAX! THEN QMAX! = QD!(I)
  IF QW!(I) > QMAX! THEN QMAX! = QW!(I)
  IF QU!(I) < QMIN! THEN QMIN! = QU!(I)
  IF QD!(I) < QMIN! THEN QMIN! = QD!(I)
  IF QW!(I) < QMIN! THEN QMIN! = QW!(I)
  IF HU!(I) > HMAX! THEN HMAX! = HU!(I)
  IF HD!(I) > HMAX! THEN HMAX! = HD!(I)
  IF HP!(I) > HMAX! THEN HMAX! = HP!(I)
  IF HU!(I) < HMIN! THEN HMIN! = HU!(I)
  IF HD!(I) < HMIN! THEN HMIN! = HD!(I)
  IF HP!(I) < HMIN! THEN HMIN! = HP!(I)
NEXT I

4100 REM CONTINUE

CLOSE #1

ISCALE% = 0
IF QMAX! > 30000 OR QMIN! < -30000 THEN
  ISCALE% = 1
  FOR I = 1 TO NPTS
    QU!(I) = .1 * QU!(I)
    QD!(I) = .1 * QD!(I)
    QW!(I) = .1 * QW!(I)
  NEXT I
  QMAX! = .1 * QMAX!
  QMIN! = .1 * QMIN!
END IF

'=========================================================================
'Setup for Normal Scientific Graph for Downstream Weir (2 Weir Case)
'=========================================================================
REDIM XTitle$(1), YTitle$(4)      'Dim arrays to hold data for the graphs
REDIM SciData!(NPTS, 3, 2), Colors(3)

MainTitle$ = "D/S Diversion        "       'underscore forces a line break

XTitle$(1) = ""
```

```
YTitle$(1) = ""
YTitle$(2) = "UPSTREAM"
YTitle$(3) = "POND"
YTitle$(4) = "DNSTREAM"

Colors(1) = 1           'Blue
Colors(2) = 2           'Green
Colors(3) = 4           'Red

FOR I = 1 TO NPTS
  SciData!(I, 1, 1) = TIME!(I)
  SciData!(I, 1, 2) = QU!(I)
  SciData!(I, 2, 1) = TIME!(I)
  SciData!(I, 2, 2) = QW!(I)
  SciData!(I, 3, 1) = TIME!(I)
  SciData!(I, 3, 2) = QD!(I)
NEXT I

TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
PointType = 0           '0 = none, 1 = square, 2 = circle, 3 = a

'Draw the normal scientific graph

TMAX! = TIME!(NPTS)
TMIN! = TIME!(1)

MAXYST = 7
YINT!(1) = 1!
YINT!(2) = 2!
YINT!(3) = 2.5
YINT!(4) = 5!
RANGE! = QMAX! - QMIN!

MF! = 1!
4910 REM CONTINUE

FOR I = 1 TO 4
  YSTEP! = MF! * YINT!(I)
  IF RANGE! / YSTEP! < MAXYST - 1 GOTO 4920
NEXT I

MF! = MF! * 10!
GOTO 4910
4920 REM CONTINUE
QMAXT! = 0

FOR I = 1 TO 10
  QMAXT! = QMAXT! + YSTEP!
  IF QMAXT! > QMAX! GOTO 4930
NEXT I

4930 REM CONTINUE
QMAX! = QMAXT!
QMINT! = 0
```

```
FOR I = 1 TO 10
  QMINT! = QMINT! - YSTEP!
  IF QMINT! < QMIN! GOTO 4940
NEXT I

4940 REM CONTINUE
QMIN! = QMINT!
NYSTEP = (QMAX! - QMIN!) / YSTEP! + .0001

GPDAT%(1) = -1
GPDAT%(5) = INT(TMAX! + 1)               'Maximum value for X axis
GPDAT%(6) = INT(TMIN!)                   'Minimum value for X axis
GPDAT%(7) = INT(TMAX! + 1) - INT(TMIN!)  'Number of steps for X axis
GPDAT%(9) = 0                            'Main Title Color
GPDAT%(51) = INT(QMAX!)                  'Maximum value for Y axis
GPDAT%(52) = INT(QMIN! + .0001)          'Minimum value for Y axis
GPDAT%(53) = NYSTEP                      'Number of steps for Y axis
GPDAT%(58) = 0                           'Headings Color
CALL Prepare

IF GPDAT%(31) <> 8 GOTO 9000

GPDAT%(37) = 100    'X screen position of the origin
GPDAT%(38) = 210    'Y screen position of the origin
GPDAT%(39) = 480    'X width of the axis
GPDAT%(40) = 180    'Y height of the axis

CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
    Colors(), Xstart, Ystart)

Size = 4
FOR I = 1 TO NPTS
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 1, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 1, 2) - LowY!) / DiffY!
  CIRCLE (XX!, YY!), Size, Colors(1)
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 2, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 2, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(2), B
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 3, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 3, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(3)
  LINE (XX! + Size, YY! - Size)-(XX! - Size, YY! + Size), Colors(3)
NEXT I

Size = 3
XSym = 19
YSym1 = 246
YSym2 = 256
YSym3 = 266
CIRCLE (XSym, YSym1), Size, Colors(1)
LINE (XSym - Size, YSym2 - Size)-(XSym + Size, YSym2 + Size), Colors(2), B
LINE (XSym - Size, YSym3 - Size)-(XSym + Size, YSym3 + Size), Colors(3)
LINE (XSym + Size, YSym3 - Size)-(XSym - Size, YSym3 + Size), Colors(3)

X = 310
Y = 245
Colr = 0
```

```
CALL DrawText(X, Y, "TIME    (hrs)", 0, Colr, TextSize#)

X = 20
Y = 140
CALL DrawText(X, Y, "Q       (cfs)", 90, Colr, TextSize#)
IF ISCALE% = 1 THEN CALL DrawText(XQ, YQ, QLABEL$, 90, Colr, TextSize#)

'=========================================================================
'Setup for SECOND graph - WEIRCREST Elevation
'=========================================================================
REDIM XTitle$(1), YTitle$(2)      'Dim arrays to hold data for the graphs
REDIM SciData!(2, 1, 2), Colors(1)

MainTitle$ = ""
XTitle$(1) = ""
YTitle$(1) = ""
YTitle$(2) = ""

Colors(1) = 0

SciData!(1, 1, 1) = INT(TMIN!)
SciData!(1, 1, 2) = WHT
SciData!(2, 1, 1) = INT(TMAX! + 1)
SciData!(2, 1, 2) = WHT

TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
PointType = 0           '0 = none, 1 = square, 2 = circle, 3 = a

'Draw the normal scientific graph

TMAX! = TIME!(NPTS)
TMIN! = TIME!(1)

MAXYST = 7
YINT!(1) = 1!
YINT!(2) = 2!
YINT!(3) = 2.5
YINT!(4) = 5!
RANGE! = HMAX! - HMIN!

MF! = 1!
5910 REM CONTINUE

FOR I = 1 TO 4
  YSTEP! = MF! * YINT!(I)
  IF RANGE! / YSTEP! < MAXYST - 1 GOTO 5920
NEXT I

MF! = MF! * 10!
GOTO 5910
5920 REM CONTINUE
HMAXT! = 0
5921 REM CONTINUE
HMAXT! = HMAXT! + YSTEP!
IF HMAXT! > HMAX! GOTO 5930
GOTO 5921
```

```
5930 REM CONTINUE
HMAX! = HMAXT!
HMINT! = HMAX!

FOR I = 1 TO 10
  HMINT! = HMINT! - YSTEP!
  IF HMINT! < HMIN! GOTO 5940
NEXT I

5940 REM CONTINUE
HMIN! = HMINT!

NYSTEP = (HMAX! - HMIN!) / YSTEP! + .0001

GPDAT%(1) = 0                          'Turns off all labels
GPDAT%(5) = INT(TMAX! + 1)             'Maximum value for X axis
GPDAT%(6) = INT(TMIN!)                 'Minimum value for X axis
GPDAT%(7) = INT(TMAX! + 1) - INT(TMIN!)  'Number of steps for X axis
GPDAT%(12) = 0                         'Turns off Main Title
GPDAT%(51) = INT(HMAX!)                'Maximum value for Y axis
GPDAT%(52) = INT(HMIN! + .0001)        'Minimum value for Y axis
GPDAT%(53) = NYSTEP                    'Number of steps for Y axis
GPDAT%(58) = 0                         'Headings Color

GPDAT%(37) = 100    'X screen position of the origin
GPDAT%(38) = 430    'Y screen position of the origin
GPDAT%(39) = 480    'X width of the axis
GPDAT%(40) = 150    'Y height of the axis

CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
   Colors(), Xstart, Ystart)

'==========================================================================
'Setup for THIRD graph - Normal Scientific Graph
'==========================================================================
REDIM XTitle$(1), YTitle$(4)      'Dim arrays to hold data for the graphs
REDIM SciData!(NPTS, 3, 2), Colors(3)

MainTitle$ = ""              'underscore forces a line break

XTitle$(1) = ""      'the first title is the X axis heading

YTitle$(1) = ""
YTitle$(2) = "UPSTREAM"
YTitle$(3) = "POND"
YTitle$(4) = "DNSTREAM"

Colors(1) = 1           'Blue
Colors(2) = 2           'Green
Colors(3) = 4           'Red

FOR I = 1 TO NPTS
  SciData!(I, 1, 1) = TIME!(I)
  SciData!(I, 1, 2) = HU!(I)
  SciData!(I, 2, 1) = TIME!(I)
  SciData!(I, 2, 2) = HP!(I)
  SciData!(I, 3, 1) = TIME!(I)
```

```
  SciData!(I, 3, 2) = HD!(I)
NEXT I

TypeOfGraph = 0         'normal (linear) line graph
LineType = 1            'complete lines drawn when LineType = 1
PointType = 0           '0 = none, 1 = square, 2 = circle, 3 = a

'Draw the normal scientific graph

GPDAT%(1) = 1                           'Turns on Axis Headings, Off Legend
GPDAT%(12) = -1                         'Turns on Main Title

GPDAT%(37) = 100    'X screen position of the origin
GPDAT%(38) = 430    'Y screen position of the origin
GPDAT%(39) = 480    'X width of the axis
GPDAT%(40) = 150    'Y height of the axis

CALL LineSci(SciData!(), XTitle$(), YTitle$(), MainTitle$, TypeOfGraph, LineType, PointType,
   Colors(), Xstart, Ystart)

Size = 4
FOR I = 1 TO NPTS
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 1, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 1, 2) - LowY!) / DiffY!
  CIRCLE (XX!, YY!), Size, Colors(1)
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 2, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 2, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(2), B
  XX! = GPDAT%(37) + GPDAT%(39) * (SciData!(I, 3, 1) - LowX!) / DiffX!
  YY! = GPDAT%(38) - GPDAT%(40) * (SciData!(I, 3, 2) - LowY!) / DiffY!
  LINE (XX! - Size, YY! - Size)-(XX! + Size, YY! + Size), Colors(3)
  LINE (XX! + Size, YY! - Size)-(XX! - Size, YY! + Size), Colors(3)
NEXT I

X = 310
Y = 465
Colr = 0
CALL DrawText(X, Y, "TIME    (hrs)", 0, Colr, TextSize#)

X = 20
Y = 375
CALL DrawText(X, Y, "Elev       (ft)", 90, Colr, TextSize#)

X = 105
Y = 2
Colr = 0
TL = LEN(L4$) - 15
CALL DrawText(X, Y, MID$(L4$, 16, TL), 0, Colr, TextSize#)

X = 105
Y = 11
TL = LEN(L6$) - 15
CALL DrawText(X, Y, MID$(L6$, 16, TL), 0, Colr, TextSize#)

X = 105
Y = 20
TL = LEN(L7$) - 15
```

```
CALL DrawText(X, Y, MID$(L7$, 16, TL), 0, Colr, TextSize#)

X = 545
Y = 20
CALL DrawText(X, Y, MID$(L2$, 16, 10), 0, Colr, TextSize#)

X = Xstart
Y = 20
CALL DrawText(X, Y, MID$(L3$, 16, 10), 0, Colr, TextSize#)

5996 REM CONTINUE
5997 IF INKEY$ = "" GOTO 5996
       IF UCASE$(INKEY$) = "P" THEN
      SizeCode$ = " 75"
      LPTNumber = 1
      XLate = -1
      CALL ScrnDump(SizeCode$, LPTNumber, XLate)
      GOTO 9000
       END IF

9000 REM CONTINUE

     END
```

6.2 - EXAMPLE INPUT DATA

6.2.1 - A1.H1D

A1.H1D is the input file for HEC-1 for the one-weir example.

```
ID   HEC1A1.DAT                 JOB NO. 117-8-E1
ID   CREATED FROM BLAHEC1U      HEC-1 MODEL  OCTOBER 1985
ID   MODIFIED KK AND DT CARDS  WHITEOAK BAYOU WATERSHED (ULTIMATE CONDITION)
ID   11/30/95                   100-YEAR STORM EVENT
IT    15 01JAN83    0000     300
IO     5       0
IN    30 01JAN83    0000
JD  12.6     .01
PI   .08     .08     .08     .08     .08     .08     .08     .08     .09     .09
PI   .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI   .17     .17     .17     .17     .28     .28     .28     .29     .70     .70
PI   3.6     1.0     .40     .40     .29     .28     .09     .09     .09     .09
PI   .08     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  12.4     10.
PI   .08     .08     .08     .08     .08     .08     .08     .08     .09     .09
PI   .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI   .17     .17     .17     .17     .28     .28     .28     .29     .71     .72
PI  3.24    1.08     .42     .41     .28     .28     .09     .09     .09     .09
PI   .08     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  12.2     25.
PI   .08     .08     .08     .08     .08     .08     .08     .09     .09     .09
PI   .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI   .17     .17     .17     .17     .28     .28     .29     .29     .72     .73
PI  2.88    1.17     .43     .43     .29     .29     .09     .09     .09     .09
PI   .09     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  12.0     50.
PI   .08     .08     .08     .08     .08     .08     .09     .09     .09     .09
PI   .09     .09     .16     .16     .16     .16     .16     .17     .17     .17
PI   .17     .17     .17     .17     .28     .29     .29     .30     .75     .76
PI  2.52    1.18     .45     .45     .30     .29     .09     .09     .09     .09
PI   .09     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  11.7    100.
PI   .08     .08     .08     .09     .09     .09     .09     .09     .09     .09
PI   .09     .09     .16     .16     .16     .16     .16     .16     .16     .16
PI   .16     .17     .17     .17     .30     .30     .30     .31     .74     .75
PI  2.18    1.16     .46     .46     .31     .30     .09     .09     .09     .09
PI   .09     .09     .09     .09     .09     .08     .08     .08
IN    30 01JAN83    0000
JD  11.5    300.
PI   .09     .09     .09     .09     .09     .09     .09     .09     .09     .09
PI   .10     .10     .17     .17     .17     .17     .17     .17     .17     .17
PI   .18     .18     .18     .18     .29     .29     .30     .30     .69     .70
PI  2.18     .82     .48     .47     .30     .29     .10     .10     .09     .09
PI   .09     .09     .09     .09     .09     .09     .09     .09
KK E100A
```

```
BA  2.81
BF     0    -.05    1.05
LE  0.25     2.0    1.86    0.43    35.0
UC  0.47    1.41
KKE100#2FROM E100#1
RS     2              -1
SV     0     181     235     344
SQ     0    1000    3500    8500
KK E100B
BA  3.83
UC  0.33    2.00
KKE100#2COMBINE HYDROGRAPHS AT JACKRABBIT ROAD (F M 1960)
HC     2
KKE100#4FROM E100#2
RS     4              -1
SV     0     693     821
SQ     0    8000   10500
KK E100C
BA 11.76
UC  1.02    3.38
KKE100#4COMBINE HYDROGRAPHS AT E127-00-00
HC     2
KKE100#6FROM E100#4
RS     2              -1
SV     0     390     465     661
SQ     0   10000   12500   20000
KKE100DD
BA  2.02
UC  0.43    1.53
KK 91378COMBINE HYDROGRAPHS UPSTREAM OF ROLLING FORK (E125-00-00)
HC     2
KO     2
KK E100D
BA  6.24
UC  0.92    2.13
KK 90428COMBINE HYDROGRAPHS DOWNSTREAM OF ROLLING FORK (E125-00-00)
HC     2
KO     2
KK 85292FROM E100#6 (STA 913+78 TO STA 850+43)
RS     1              -1
RC  0.12   0.035    0.12    6335 0.00095
RX     0       1       2      77     147     222     223     224
RY    25      25      25       0       0      25      25      25
KO     2
KK 85042DIVERT FLOW TO POND 25
DT 85167
DI     0    5000   12000   18000   25000
DQ     0       0       0    6000   13000
KO     2
KK 77969FROM E100#7 (STA 850+43 TO STA 779+68)
RS     1              -1
RC  0.12   0.035    0.12    7075  0.0008
RX     0       1       2      62     107     167     168     169
RY    24      24      24       0       0      24      24      24
KO     2
KKE100EE
BA  2.29
```

```
UC  0.58    1.99
KK 77968COMBINE HYDROGRAPHS UPSTREAM OF E122-00-00
HC     2
KO     2
KK E100E
BA  4.52
UC  0.81    2.29
KK 76912COMBINE HYDROGRAPHS DOWNSTREAM OF E122-00-00
HC     2
KO     2
KK 65246FROM E100#8 (STA 779+68 TO STA 652+45)
RS     3              -1
SV     0     222     373     508     634     937    1068
SQ     0    3300    6600    9900   13200   16500   17000
KO     2
KK E100F
BA  2.15
UC  0.75    1.79
KK 65245COMBINE HYDROGRAPHS UPSTREAM OF VOGEL CREEK (E121-00-00)
KO     2
HC     2
ZZ
```

6.2.2 - A1CULV.H1D

A1CULV.H1D is the base input file for HEC-1 for one set of diversion culverts. This file is the same as A1.H1D in Appendix 6.2.1 except for station numbering and initial estimates of diversion. The lines that have been changed in the file are underlined in this Appendix.

```
ID   HEC1A1.DAT                JOB NO. 117-8-E1
ID   CREATED FROM BLAHEC1U     HEC-1 MODEL  OCTOBER 1985
ID   MODIFIED KK AND DT CARDS  WHITEOAK BAYOU WATERSHED (ULTIMATE CONDITION)
ID   11/30/95                  100-YEAR STORM EVENT
IT    15 01JAN83    0000     300
IO     5       0
IN    30 01JAN83    0000
JD  12.6     .01
PI   .08     .08     .08     .08     .08     .08     .08     .08     .09     .09
PI   .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI   .17     .17     .17     .17     .28     .28     .28     .29     .70     .70
PI   3.6     1.0     .40     .40     .29     .28     .09     .09     .09     .09
PI   .08     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  12.4     10.
PI   .08     .08     .08     .08     .08     .08     .08     .08     .09     .09
PI   .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI   .17     .17     .17     .17     .28     .28     .28     .29     .71     .72
PI  3.24    1.08     .42     .41     .28     .28     .09     .09     .09     .09
PI   .08     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  12.2     25.
PI   .08     .08     .08     .08     .08     .08     .08     .09     .09     .09
PI   .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI   .17     .17     .17     .17     .28     .28     .29     .29     .72     .73
PI  2.88    1.17     .43     .43     .29     .29     .09     .09     .09     .09
PI   .09     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  12.0     50.
PI   .08     .08     .08     .08     .08     .08     .09     .09     .09     .09
PI   .09     .09     .16     .16     .16     .16     .16     .17     .17     .17
PI   .17     .17     .17     .17     .28     .29     .29     .30     .75     .76
PI  2.52    1.18     .45     .45     .30     .29     .09     .09     .09     .09
PI   .09     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  11.7    100.
PI   .08     .08     .08     .09     .09     .09     .09     .09     .09     .09
PI   .09     .09     .16     .16     .16     .16     .16     .16     .16     .16
PI   .16     .17     .17     .17     .30     .30     .30     .31     .74     .75
PI  2.18    1.16     .46     .46     .31     .30     .09     .09     .09     .09
PI   .09     .09     .09     .09     .09     .08     .08     .08
IN    30 01JAN83    0000
JD  11.5    300.
PI   .09     .09     .09     .09     .09     .09     .09     .09     .09     .09
PI   .10     .10     .17     .17     .17     .17     .17     .17     .17     .17
PI   .18     .18     .18     .18     .29     .29     .30     .30     .69     .70
PI  2.18     .82     .48     .47     .30     .29     .10     .10     .09     .09
PI   .09     .09     .09     .09     .09     .09     .09     .09
KK E100A
```

```
BA  2.81
BF     0    -.05    1.05
LE  0.25     2.0    1.86    0.43    35.0
UC  0.47    1.41
KKE100#2FROM E100#1
RS     2               -1
SV     0     181     235     344
SQ     0    1000    3500    8500
KK E100B
BA  3.83
UC  0.33    2.00
KKE100#2COMBINE HYDROGRAPHS AT JACKRABBIT ROAD (F M 1960)
HC     2
KKE100#4FROM E100#2
RS     4               -1
SV     0     693     821
SQ     0    8000   10500
KK E100C
BA 11.76
UC  1.02    3.38
KKE100#4COMBINE HYDROGRAPHS AT E127-00-00
HC     2
KKE100#6FROM E100#4
RS     2               -1
SV     0     390     465     661
SQ     0   10000   12500   20000
KKE100DD
BA  2.02
UC  0.43    1.53
KK 91378COMBINE HYDROGRAPHS UPSTREAM OF ROLLING FORK (E125-00-00)
HC     2
KO     2
KK E100D
BA  6.24
UC  0.92    2.13
KK 90428COMBINE HYDROGRAPHS DOWNSTREAM OF ROLLING FORK (E125-00-00)
HC     2
KO     2
KK 85089FROM E100#6 (STA 913+78 TO STA 850+43)
RS     1               -1
RC  0.12   0.035    0.12    6335 0.00095
RX     0       1       2      77     147     222     223     224
RY    25      25      25       0       0      25      25      25
KO     2
KK 85042DIVERT FLOW TO POND 25
DT 85066
DI     0    5000   12000   20000   25000
DQ     0       0       0       0    3000
KO     2
KK 77969FROM E100#7 (STA 850+43 TO STA 779+68)
RS     1               -1
RC  0.12   0.035    0.12    7075  0.0008
RX     0       1       2      62     107     167     168     169
RY    24      24      24       0       0      24      24      24
KO     2
KKE100EE
BA  2.29
```

```
UC  0.58    1.99
KK 77968COMBINE HYDROGRAPHS UPSTREAM OF E122-00-00
HC     2
KO     2
KK E100E
BA  4.52
UC  0.81    2.29
KK 76912COMBINE HYDROGRAPHS DOWNSTREAM OF E122-00-00
HC     2
KO     2
KK 65246FROM E100#8 (STA 779+68 TO STA 652+45)
RS     3              -1
SV     0     222     373     508     634     937    1068
SQ     0    3300    6600    9900   13200   16500   17000
KO     2
KK E100F
BA  2.15
UC  0.75    1.79
KK 65245COMBINE HYDROGRAPHS UPSTREAM OF VOGEL CREEK (E121-00-00)
KO     2
HC     2
ZZ
```

6.2.3 - B1.H1D

B1.H1D is the input file for HEC-1 for the two-weir example.

```
ID   HEC1A1.DAT                 JOB NO. 117-8-E1
ID   CREATED FROM BLAHEC1U      HEC-1 MODEL  OCTOBER 1985
ID   MODIFIED KK AND DT CARDS  WHITEOAK BAYOU WATERSHED (ULTIMATE CONDITION)
ID   11/30/95                   100-YEAR STORM EVENT
IT    15 01JAN83    0000     300
IO     5       0
IN    30 01JAN83    0000
JD  12.6     .01
PI   .08     .08     .08     .08     .08     .08     .08     .08     .09     .09
PI   .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI   .17     .17     .17     .17     .28     .28     .28     .29     .70     .70
PI   3.6     1.0     .40     .40     .29     .28     .09     .09     .09     .09
PI   .08     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  12.4     10.
PI   .08     .08     .08     .08     .08     .08     .08     .08     .09     .09
PI   .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI   .17     .17     .17     .17     .28     .28     .28     .29     .71     .72
PI  3.24    1.08     .42     .41     .28     .28     .09     .09     .09     .09
PI   .08     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  12.2     25.
PI   .08     .08     .08     .08     .08     .08     .08     .09     .09     .09
PI   .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI   .17     .17     .17     .17     .28     .28     .29     .29     .72     .73
PI  2.88    1.17     .43     .43     .29     .29     .09     .09     .09     .09
PI   .09     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  12.0     50.
PI   .08     .08     .08     .08     .08     .08     .09     .09     .09     .09
PI   .09     .09     .16     .16     .16     .16     .16     .17     .17     .17
PI   .17     .17     .17     .17     .28     .29     .29     .30     .75     .76
PI  2.52    1.18     .45     .45     .30     .29     .09     .09     .09     .09
PI   .09     .08     .08     .08     .08     .08     .08     .08
IN    30 01JAN83    0000
JD  11.7    100.
PI   .08     .08     .08     .09     .09     .09     .09     .09     .09     .09
PI   .09     .09     .16     .16     .16     .16     .16     .16     .16     .16
PI   .16     .17     .17     .17     .30     .30     .30     .31     .74     .75
PI  2.18    1.16     .46     .46     .31     .30     .09     .09     .09     .09
PI   .09     .09     .09     .09     .09     .08     .08     .08
IN    30 01JAN83    0000
JD  11.5    300.
PI   .09     .09     .09     .09     .09     .09     .09     .09     .09     .09
PI   .10     .10     .17     .17     .17     .17     .17     .17     .17     .17
PI   .18     .18     .18     .18     .29     .29     .30     .30     .69     .70
PI  2.18     .82     .48     .47     .30     .29     .10     .10     .09     .09
PI   .09     .09     .09     .09     .09     .09     .09     .09
KK E100A
BA  2.81
BF     0    -.05    1.05
LE  0.25     2.0    1.86    0.43    35.0
```

```
UC  0.47    1.41
KKE100#2FROM E100#1
RS     2              -1
SV     0     181     235     344
SQ     0    1000    3500    8500
KK E100B
BA  3.83
UC  0.33    2.00
KKE100#2COMBINE HYDROGRAPHS AT JACKRABBIT ROAD (F M 1960)
HC     2
KKE100#4FROM E100#2
RS     4              -1
SV     0     693     821
SQ     0    8000   10500
KK E100C
BA 11.76
UC  1.02    3.38
KKE100#4COMBINE HYDROGRAPHS AT E127-00-00
HC     2
KKE100#6FROM E100#4
RS     2              -1
SV     0     390     465     661
SQ     0   10000   12500   20000
KKE100DD
BA  2.02
UC  0.43    1.53
KK 91378COMBINE HYDROGRAPHS UPSTREAM OF ROLLING FORK (E125-00-00)
HC     2
KO     2
KK E100D
BA  6.24
UC  0.92    2.13
KK 90428COMBINE HYDROGRAPHS DOWNSTREAM OF ROLLING FORK (E125-00-00)
HC     2
KO     2
KK 85292FROM E100#6 (STA 913+78 TO STA 850+43)
RS     1              -1
RC  0.12   0.035    0.12    6335 0.00095
RX     0       1       2      77     147     222     223     224
RY    25      25      25       0       0      25      25      25
KO     2
KK 85042DIVERT FLOW TO POND 25
DT 85167
DI     0    5000   12000   18000   25000
DQ     0       0       0       0    6000
KO     2
KK 77969FROM E100#7 (STA 850+43 TO STA 779+68)
RS     1              -1
RC  0.12   0.035    0.12    7075  0.0008
RX     0       1       2      62     107     167     168     169
RY    24      24      24       0       0      24      24      24
KO     2
KKE100EE
BA  2.29
UC  0.58    1.99
KK 77112COMBINE HYDROGRAPHS UPSTREAM OF E122-00-00
HC     2
```

```
KO     2
KK E100E
BA  4.52
UC  0.81    2.29
KK 76914COMBINE HYDROGRAPHS DOWNSTREAM OF E122-00-00
HC     2
KO     2
KK 76912DIVERT FLOW TO POND 26
DT 77012
DI     0    5000   12000   18000   25000
DQ     0       0       0    6000   13000
KO     2
KK 65246FROM E100#8 (STA 779+68 TO STA 652+45)
RS     3              -1
SV     0     222     373     508     634     937    1068
SQ     0    3300    6600    9900   13200   16500   17000
KO     2
KK E100F
BA  2.15
UC  0.75    1.79
KK 65245COMBINE HYDROGRAPHS UPSTREAM OF VOGEL CREEK (E121-00-00)
KO     2
HC     2
ZZ
```

6.2.4 - B1CULV.H1D

B1CULV.H1D is the base input file for HEC-1 for two sets of diversion culverts. This file is the same as B1.H1D in Appendix 6.2.3 except for station numbering and initial estimates of diversion. The lines that have been changed in the file are underlined in this Appendix.

```
ID   HEC1A1.DAT                  JOB NO. 117-8-E1
ID   CREATED FROM BLAHEC1U       HEC-1 MODEL  OCTOBER 1985
ID   MODIFIED KK AND DT CARDS  WHITEOAK BAYOU WATERSHED (ULTIMATE CONDITION)
ID   11/30/95                    100-YEAR STORM EVENT
IT     15 01JAN83    0000     300
IO      5       0
IN     30 01JAN83    0000
JD   12.6     .01
PI    .08     .08     .08     .08     .08     .08     .08     .08     .09     .09
PI    .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI    .17     .17     .17     .17     .28     .28     .28     .29     .70     .70
PI    3.6     1.0     .40     .40     .29     .28     .09     .09     .09     .09
PI    .08     .08     .08     .08     .08     .08     .08     .08
IN     30 01JAN83    0000
JD   12.4     10.
PI    .08     .08     .08     .08     .08     .08     .08     .08     .09     .09
PI    .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI    .17     .17     .17     .17     .28     .28     .28     .29     .71     .72
PI   3.24    1.08     .42     .41     .28     .28     .09     .09     .09     .09
PI    .08     .08     .08     .08     .08     .08     .08     .08
IN     30 01JAN83    0000
JD   12.2     25.
PI    .08     .08     .08     .08     .08     .08     .08     .09     .09     .09
PI    .09     .09     .16     .16     .16     .16     .17     .17     .17     .17
PI    .17     .17     .17     .17     .28     .28     .29     .29     .72     .73
PI   2.88    1.17     .43     .43     .29     .29     .09     .09     .09     .09
PI    .09     .08     .08     .08     .08     .08     .08     .08
IN     30 01JAN83    0000
JD   12.0     50.
PI    .08     .08     .08     .08     .08     .08     .09     .09     .09     .09
PI    .09     .09     .16     .16     .16     .16     .16     .17     .17     .17
PI    .17     .17     .17     .17     .28     .29     .29     .30     .75     .76
PI   2.52    1.18     .45     .45     .30     .29     .09     .09     .09     .09
PI    .09     .08     .08     .08     .08     .08     .08     .08
IN     30 01JAN83    0000
JD   11.7    100.
PI    .08     .08     .08     .09     .09     .09     .09     .09     .09     .09
PI    .09     .09     .16     .16     .16     .16     .16     .16     .16     .16
PI    .16     .17     .17     .17     .30     .30     .30     .31     .74     .75
PI   2.18    1.16     .46     .46     .31     .30     .09     .09     .09     .09
PI    .09     .09     .09     .09     .09     .08     .08     .08
IN     30 01JAN83    0000
JD   11.5    300.
PI    .09     .09     .09     .09     .09     .09     .09     .09     .09     .09
PI    .10     .10     .17     .17     .17     .17     .17     .17     .17     .17
PI    .18     .18     .18     .18     .29     .29     .30     .30     .69     .70
PI   2.18     .82     .48     .47     .30     .29     .10     .10     .09     .09
PI    .09     .09     .09     .09     .09     .09     .09     .09
```

```
KK E100A
BA  2.81
BF     0    -.05    1.05
LE  0.25     2.0    1.86    0.43    35.0
UC  0.47    1.41
KKE100#2FROM E100#1
RS     2              -1
SV     0     181     235     344
SQ     0    1000    3500    8500
KK E100B
BA  3.83
UC  0.33    2.00
KKE100#2COMBINE HYDROGRAPHS AT JACKRABBIT ROAD (F M 1960)
HC     2
KKE100#4FROM E100#2
RS     4              -1
SV     0     693     821
SQ     0    8000   10500
KK E100C
BA 11.76
UC  1.02    3.38
KKE100#4COMBINE HYDROGRAPHS AT E127-00-00
HC     2
KKE100#6FROM E100#4
RS     2              -1
SV     0     390     465     661
SQ     0   10000   12500   20000
KKE100DD
BA  2.02
UC  0.43    1.53
KK 91378COMBINE HYDROGRAPHS UPSTREAM OF ROLLING FORK (E125-00-00)
HC     2
KO     2
KK E100D
BA  6.24
UC  0.92    2.13
KK 90428COMBINE HYDROGRAPHS DOWNSTREAM OF ROLLING FORK (E125-00-00)
HC     2
KO     2
KK 85089FROM E100#6 (STA 913+78 TO STA 850+43)
RS     1              -1
RC  0.12   0.035    0.12    6335 0.00095
RX     0       1       2      77     147     222     223     224
RY    25      25      25       0       0      25      25      25
KO     2
KK 85042DIVERT FLOW TO POND 25
DT 85066
DI     0    5000   12000   18000   26000
DQ     0       0       0       0    2000
KO     2
KK 77969FROM E100#7 (STA 850+43 TO STA 779+68)
RS     1              -1
RC  0.12   0.035    0.12    7075  0.0008
RX     0       1       2      62     107     167     168     169
RY    24      24      24       0       0      24      24      24
KO     2
KKE100EE
```

```
BA  2.29
UC  0.58    1.99
KK 76959COMBINE HYDROGRAPHS UPSTREAM OF E122-00-00
HC     2
KO     2
KK E100E
BA  4.52
UC  0.81    2.29
KK 76914COMBINE HYDROGRAPHS DOWNSTREAM OF E122-00-00
HC     2
KO     2
KK 76912DIVERT FLOW TO POND 26
DT 76936
DI     0    5000   12000   18000   26000
DQ     0       0       0       0    3500
KO     2
KK 65246FROM E100#8 (STA 779+68 TO STA 652+45)
RS     3              -1
SV     0     222     373     508     634     937    1068
SQ     0    3300    6600    9900   13200   16500   17000
KO     2
KK E100F
BA  2.15
UC  0.75    1.79
KK 65245COMBINE HYDROGRAPHS UPSTREAM OF VOGEL CREEK (E121-00-00)
KO     2
HC     2
ZZ
```

6.2.5 - A1.H2D

A1.H2D is the input file for HEC-2 for the one-weir and the two-weir examples and for the one-diversion culvert and the two-diversion culvert examples. The same HEC-2 input files can be used for all examples since only the DNWEIR station number is needed in the HEC-2 input file.

```
T1      WHITE OAK BAYOU IMPROVEMENT STUDY
T2      100 YEAR ULTIMATE FLOW
T3      WHITE OAK BAYOU
J1   -10       2               .0005                              25
J2                    -1                                 7
J3    38      43       1       8
J5   -10     -10
J6     1
NC   .12     .12    .035      .3      .5
QT     1   17000
X1 65245      18   23708   23865    1600    1200    1531
CI    -1   50.94   0.035     2.5     2.5     -50     -50
GR    85   19700      80   22030      78   22900      78   22950      78   23050
GR    78   23708    63.9   23743    61.5   23784    60.5   23785    60.1   23792
GR  60.5   23800    61.9   23801      63   23819    78.2   23865    75.9   24000
GR  76.6   24200      80   24350      85   26300
X1 65667      13   20000   20180     350     700     422
CI    -1   51.28   0.035     2.5     2.5     -50     -50
GR    85   15950      80   18090    78.5   18400    78.5   19520      78   20000
GR  76.3   20001   51.28   20068   51.28   20113    76.3   20180    76.3   20201
GR  78.6   20202    80.0   20750    85.0   22500
X1 65720      13   20000   20176      53      53      53
CI                                           .01     .01
GR    85   15950      80   18090    78.5   18400    78.5   19520      78   20000
GR  76.3   20001   51.32   20051   51.32   20126    76.3   20176    76.3   20201
GR  78.6   20202    80.0   20750    85.0   22500
SB  1.05     1.5     3.0              80       3    3229     2.0    51.3    51.3
X1 65773                              53      53      53
X2                     1    76.6    78.5
BT    -8   15950    85.0           18090    80.0           18400    78.5
BT         19520    78.5           20000    78.6           20202    78.6
BT         20750    80.0           22500    85.0
X1 65826                              53      53      53
CI    -1   51.41   0.035     2.5     2.5     -50     -50
X1 66882      12   20000   20173    1400     550    1056
CI    -1   52.25   0.035     2.5     2.5     -50     -50
GR    81   16850      80   16900      79   18290      79   18350      79   18450
GR    79   19300    76.7   20000   52.25   20064   52.25   20109    76.7   20173
GR  80.0   20200    85.0   22075
X1 66935      12   20000   20173      53      53      53
CI                                           .01     .01
GR    81   16850      80   16900      79   18290      79   18350      79   18450
GR    79   19300    76.7   20000   52.25   20049   52.25   20124    76.7   20173
GR  80.0   20200    85.0   22075
SB  1.05     1.5     2.5              75       3    2948     2.0    52.3    52.3
X1 66988                              53      53      53
X2                     1    76.7    78.6
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BT    -5   20000    77.6            20001    78.7            20087    78.9
BT         20175    78.6            20176    77.6
X1 66993      12   20000   20171        5       5       5
GR    81   16850      80   16900       79   18290      79   18350      79   18450
GR    79   19300    76.3   20000    52.34   20048   52.34   20123    76.3   20171
GR  80.0   20200    85.0   22075
SB  1.05     1.5     2.5               75       4    2908     2.0    52.3    52.3
X1 67041                               48      48      48
X2                     1    76.6     78.4
BT    -5   20000    78.0            20001    78.5            20087    78.5
BT         20175    78.4            20176    77.9
X1 67094                               53      53      53
CI    -1   52.42    .035     2.5      2.5     -50     -50
X1 67200      16   20116   20267       25     250     106
CI    -1   52.51   0.035     2.5      2.5     -50     -50
GR    83   16500      79   18300       79   18400      79   18500    76.8   20000
GR  76.8   20001    77.5   20100     77.7   20116    76.3   20117    61.5   20166
GR  60.0   20182    61.7   20207     75.6   20247    76.3   20266    76.4   20267
GR    85   22100
X1 67253                               53      53      53
CI    -1   52.55   0.035     2.5      2.5     -50     -50
X1 67257                                4       4       4
CI    -1   52.55   0.035     2.5      2.5     -50     -50
X1 67306      16   20116   20267       49      49      49
CI    -1   52.59   0.035     2.5      2.5     -50     -50
GR    83   16500      79   18300       79   18400      79   18500    76.8   20000
GR  76.8   20001    77.5   20100     77.7   20116    76.3   20117    61.5   20166
GR  60.0   20182    61.7   20207     75.6   20247    76.3   20266    76.4   20267
GR    85   22100
X1 67623      20   20000   20134      300     400     317
CI    -1   52.85   0.035     2.5      2.5     -50     -50
GR    83   16310      79   18400       79   18450      79   18550    79.8   20000
GR  78.7   20012    75.6   20022     70.3   20029      69   20040    63.8   20045
GR    63   20065      62   20066     61.2   20072    62.5   20083    64.7   20084
GR  67.4 20098.5    71.2   20104     78.7   20131    79.8   20134      85   22275
X1 67676                               53      53      53
CI    -1   52.89   0.035     2.5      2.5     -50     -50
X1 67728                               52      52      52
CI    -1   52.93   0.035     2.5      2.5     -50     -50
X1 67782      20   20000   20134       54      54      54
CI    -1   52.97   0.035     2.5      2.5     -40     -40
GR    83   16310      79   18400       79   18450      79   18550    79.8   20000
GR  78.7   20012    75.6   20022     70.3   20029      69   20040    63.8   20045
GR    63   20065      62   20066     61.2   20072    62.5   20083    64.7   20084
GR  67.4 20098.5    71.2   20104     78.7   20131    79.8   20134      85   22275
X1 68468      17   20300   20442      800     600     686
CI    -1   53.52    .035     2.5      2.5     -40     -40
GR    84   18940      82   18950     76.5   20000    77.2   20100    78.9   20200
GR  79.3   20300    67.4   20344     64.5   20376    62.8   20378    61.5   20385
GR  62.4   20392    64.4   20395     65.6   20406      79   20442    78.7   20500
GR  78.4   20600      85   22480
QT     1   16800
X1 68890      14   20000   20096      400     400     422
CI    -1   53.86   0.035     2.5      2.5     -40     -40
X4     2    79.4   19397    79.2    20661
GR    84   18640      82   18650     77.3   20000    75.7   20001    64.5   20038
GR  63.3   20040      63   20041       62   20050      63   20059    64.8   20060
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GR  67.3   20075    75.8   20095    77.3   20096      85   22300
X1 68943                            53      53      53
CI    -1   53.90   0.035     2.5     2.5     -40     -40
X1 68995                            52      52      52
CI    -1   53.94   0.035     2.5     2.5     -40     -40
X1 69049      14   20000   20096      54      54      54
CI    -1   53.99   0.035     2.5     2.5     -40     -40
GR    84   18640      82   18650    77.3   20000    75.7   20001    64.5   20038
GR  63.3   20040      63   20041      62   20050      63   20059    64.8   20060
GR  67.3   20075    75.8   20095    77.3   20096      85   22300
X1 70105      67   24200   24333    1150     850    1056
CI    -1   54.83   0.035     2.5     2.5     -40     -40
GR    85   20850      85   20851    81.2   22400    78.9   22450    78.4   22451
GR    79   22464    78.7   22478    79.1   22479    79.8   22600    77.8   22800
GR  77.3   22800    77.7   22814    77.2   22828    77.6   22829    79.5   23000
GR  79.8   23200    77.8   23400    78.4   23600    77.7   23782    77.2   23783
GR  77.6   23796    77.5   23810    77.9   23811    78.4   24000    78.4   24150
GR  79.2   24200    68.9   24228    63.3   24242    62.2   24256    64.3   24283
GR  79.8   24333    79.7   24383    79.7   24384    79.4   24400    78.5   24600
GR  78.5   24800    79.3   25000    79.9   25200    80.1   25400    80.8   25600
GR    81   25800    82.2   26000    80.7   26074    80.2   26075    80.5   26086
GR  80.8   26098    81.2   26099    79.7   26113    81.2   26127    80.7   26139
GR  80.5   26151    82.2   26200    81.9   26216    80.1   26237    82.9   26253
GR  82.8   26267      82   26290    81.4   26306      82   26326    81.2   26400
GR  82.3   26600      82   26800    82.1   26870    80.6   26910    83.1   26980
GR  84.8   26990    85.2   26997
X1 70505      12   12000   12154     500     250     400
CI    -1   55.15   0.035     2.5     2.5     -40     -40
GR  84.0   10000    79.7   11070    83.5   11990    79.8   11991    79.8   12000
GR 55.15   12062   55.15   12092    79.8   12154    79.8   12194    83.5   12195
GR  81.1   12425    82.3   13065    85.0   14115
X1 70605      12   11990   12164   100.0   100.0   100.0
CI                                           .01     .01
GR  84.0   10000    79.7   11070    83.5   11990    79.8   11991   55.15   12040
GR 55.15   12115    79.8   12164    79.8   12194    83.5   12195    81.1   12425
GR  82.3   13065    85.0   14115
SB  1.05     1.5     2.6              75       3    2996     2.0    55.2    55.2
X1 70665                            60      60      60
X2                     1    79.8    83.5
BT    -4   11990    83.5           11991    83.5           12194    83.5
BT         12195    83.5
X1 70725                          60.0    60.0    60.0
CI    -1   55.33   0.035     2.5     2.5     -40     -40
X1 72164      50   23654   23800    1080     880    1439
CI    -1   56.48   0.035     2.5     2.5     -40     -40
GR    90   20200      85   22225    84.7   22600    83.3   22800    80.5   22943
GR  78.8   22955    81.4   22964    81.6   22971    81.8   22981    81.6   22991
GR  80.8   22998    78.4   23006    80.6   23014    80.6   23200    79.7   23372
GR  79.2   23373    79.8   23386    79.4   23400    79.8   23401    82.5   23600
GR  82.2   23629    82.4   23654    65.1   23706    64.2   23722    65.3   23749
GR  66.5   23753    68.4   23755    80.7   23800    80.6   23824      80   24000
GR  78.9   24200      79   24400    79.3   24600    79.3   24712    78.9   24712
GR  79.1   24726    78.7   24740    79.3   24740    80.3   24800    81.2   25000
GR  81.7   25200    81.6   25400    81.4   25600    81.5   25800    81.4   25879
GR  80.7   25906    83.7   25990    85.1   25995    85.6   25998    85.1   26000
QT     1   16400
X1 73114      21   20008   20182    1150     600     950
```

CI	-1	57.24	0.035	2.5	2.5	-40	-40			
GR	90	17500	85	19100	80.8	20000	81.1	20007	83.9	20008
GR	81	20042	77.8	20047	73.5	20055	72.3	20077	70.5	20087
GR	67.2	20091	66.1	20097	67.2	20103	70	20112	75	20140
GR	77.6	20146	80.7	20181	83.9	20182	79.7	20191	85	22150
GR	87	23125								
X1	73167				53	53	53			
CI	-1	57.28	0.035	2.5	2.5	-40	-40			
X1	73171				4	4	4			
CI	-1	57.28	0.035	2.5	2.5	-40	-40			
X1	73198	21	20008	20182	27	27	27			
CI	-1	57.31	0.035	2.5	2.5	-40	-40			
GR	90	17500	85	19100	80.8	20000	81.1	20007	83.9	20008
GR	81	20042	77.8	20047	73.5	20055	72.3	20077	70.5	20087
GR	67.2	20091	66.1	20097	67.2	20103	70	20112	75	20140
GR	77.6	20146	80.7	20181	83.9	20182	79.7	20191	85	22150
GR	87	23125								
X1	73219	17	20000	20123	21	21	21			
CI	-1	57.32	0.035	2.5	2.5	-40	-40			
GR	90	17650	85	19100	84	20000	84	20002	82.1	20003
GR	75.2	20032	70.5	20040	69.4	20066	68.3	20069	67.4	20079
GR	67.1	20088	71.2	20090	73.6	20110	83.9	20123	85	21850
GR	85	22150	87	23050						
X1	73244	9	20000	20123	25	25	25			
CI						.01	.01			
GR	90.0	17650	85.0	19100	84.0	20000	57.34	20040	57.34	20083
GR	83.9	20123	85.0	21850	85.0	22150	87.0	23050		
SB	1.05	1.5	3.0		43	4	2102	1.5	57.3	57.3
X1	73270				26	26	26			
X2			1	83.9	86.0					
BT	-26	18200	91.3		18400	91		18600	90.6	
BT		18800	90.3		19000	89.9		19200	89.5	
BT		19400	89.2		19600	88.7		19800	88.3	
BT		20000	87.0		20200	87.1		20400	86.8	
BT		20600	86.6		20800	86.6		21000	86.5	
BT		21200	86.6		21270	86.6		21340	86.5	
BT		21400	86.5		21600	86.4		21800	86.3	
BT		22000	86.1		22200	86.0		22400	86.0	
BT		22600	86.1		22800	86.1				
QT	1	16400								
X1	73296				26	26	26			
CI	-1	57.38	0.035	2.5	2.5	-40	-40			
QT	1	16400								
X1	74431	18	20200	20356	400	1200	1135			
CI	-1	58.29	0.035	2.5	2.5	-45	-70			
GR	90	18650	85	19750	82.7	20000	84	20100	87.5	20200
GR	82.4	20220	73.3	20250	72.2	20275	66	20280	64	20288
GR	66.4	20297	71.2	20301	71.8	20314	85.6	20356	83.5	20400
GR	85	21000	87.5	23800	90	23810				
X1	75962	29	22526	22664	1400	1400	1531			
CI	-1	59.52	0.035	2.5	2.5	-45	-70			
GR	89.9	20000	89.9	20200	88.9	20400	88.5	20600	87.9	20800
GR	87.5	21000	86.8	21200	85.5	21400	84.2	21600	83.9	21800
GR	83.9	22000	84.4	22200	84.2	22400	86.5	22526	84.1	22536
GR	75.8	22551	74.2	22577	69.8	22583	66.0	22591	69.8	22600
GR	73.2	22603	75.1	22638	85.8	22664	84.2	22800	84.9	23000
GR	84.7	23200	85.7	23400	87.5	26550	90	26560		

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X1 76068      15   20000   20088     106     106     106
CI    -1   59.60   0.035     2.5     2.5     -45     -70
GR    95   16700      90   18300    87.7   20000    83.4   20001    76.9   20017
GR  65.6   20035    65.1   20043    65.4   20052    74.3   20069    81.4   20087
GR  87.7   20088    87.8   20494    87.5   20694    89.3   20896    90.0   23994
X1 76121                              53      53      53
CI    -1   59.64   0.035     2.5     2.5     -45     -70
X1 76146      15   20000   20088      25      25      25
CI    -1   59.66   0.035     2.5     2.5     -45     -70
GR    95   16700      90   18300    87.7   20000    83.4   20001    76.9   20017
GR  65.6   20035    65.1   20043    65.4   20052    74.3   20069    81.4   20087
GR  87.7   20088    87.8   20494    87.5   20694    89.3   20896    90.0   23994
X1 76199                              53      53      53
CI    -1   59.71   0.035     2.5     2.5     -45     -70
QT     1   16000
X1 76912      13   20200   20337     600     600     713
CI    -1   60.28   0.035     2.5     2.5     -45     -70
GR    90   18450    84.7   20000    84.9   20150    85.6   20200    74.6   20231
GR  69.1   20254    75.5   20278    75.8   20300      86   20337    86.1   20364
GR    85   20465      88   24200      90   24210
QT     1   13800
X1 77112      14   20100   20247    1200     850    1056
CI    -1   61.12   0.035     2.5     2.5     -45     -45
GR    90   17450    86.5   20000    88.5   20050    88.6   20100    76.1   20133
GR  74.7   20151    68.2   20166    74.6   20196    75.9   20206    88.1   20247
GR  87.3   20295    87.3   20395      89   23950      90   23960
X1 79552      13   20080   20222    1100    1150    1584
CI    -1   62.39   0.035     2.5     2.5     -45     -45
GR    90   16825    89.6   20000    89.6   20050    89.6   20080      75   20125
GR  71.6   20153    75.1   20182    87.6   20222    86.4   20250    86.3   20350
GR    90   20850      91   23000      92   23010
X1 80661      78   22594   22736    1000    1150    1109
CI    -1   63.28   0.035     2.5     2.5     -45     -45
GR    95   18600      90   19850    88.5   20600    87.6   20647      87   20648
GR  87.6   20661    87.8   20684    88.4   20685    88.2   20703    87.6   20704
GR  87.5   20716    87.0   20728    87.6   20729    88.1   20800    87.7   20987
GR  87.2   20988    87.6   21001    87.2   21014    87.7   21015    88.3   21200
GR  87.2   21271    86.7   21272    87.2   21285    86.8   21298    87.3   21299
GR  88.5   21400    87.1   21554    86.5   21555    87.3   21568    86.6   21582
GR  87.2   21582      88   21600    88.2   21800    87.1   21837    86.5   21838
GR  87.3   21851    86.6   21864    87.2   21865    88.4   22000    87.2   22122
GR  86.7   22123    87.2   22136    86.8   22150    87.3   22151    88.1   22200
GR  87.4   22400    87.2   22406    86.7   22406    87.2   22420    86.5   22434
GR  87.2   22434    89.6   22594    88.4   22600    77.7   22633      75   22650
GR  73.5   22655    74.3   22660    76.3   22667      78   22705    89.1   22736
GR    90   22800    89.2   23000    89.2   23200    88.9   23400      89   23600
GR  89.3   23800    89.5   24000    90.1   24200    89.7   24400    89.9   24600
GR    90   24800    91.2   25000    90.8   25200    90.9   25400    91.2   25600
GR  90.8   25724    90.3   25730    92.1   25762
QT     1   13400
X1 82139      17   20200   20348    1350    1550    1478
CI    -1   64.46   0.035     2.5     2.5     -45     -45
GR   100   15900      95   16950      90   18000      90   18650    88.9   20000
GR  89.5   20150    91.2   20200    78.2   20240    78.3   20280    74.1   20289
GR  78.3   20294    77.8   20303    92.9   20348    91.9   20388      91   20490
GR    92   23400      93   23450
X1 83934      62   22500   22645    1300    1500    1795
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CI	-1	65.89	0.035	2.5	2.5	-45	-45			
GR	95.5	20000	95.1	20200	94	20400	93.7	20600	93.6	20800
GR	95.4	21000	94.3	21200	93.6	21400	92.6	21600	92.1	21800
GR	91.7	22200	91.3	22400	90.7	22500	78.3	22540	76.2	22560
GR	78.4	22600	93.2	22645	92.4	22800	90.7	22935	90.2	22936
GR	90.6	22965	90.8	22996	90.6	23000	90.5	23189	90.0	23190
GR	90.5	23200	90.0	23228	90.5	23229	91.6	23400	90.5	23500
GR	90.0	23501	90.5	23515	90.0	23530	90.4	23531	91.9	23600
GR	90.4	23629	89.9	23630	90.4	23643	90	23658	90.5	23659
GR	91.2	23800	91.3	24000	90.0	24120	89.5	24121	90.1	24135
GR	89.5	24150	90.0	24151	91.6	24200	91.6	24400	92.2	24600
GR	91.1	24631	90.7	24632	91.2	24645	90.7	24660	91.1	24661
GR	92.4	24700	91.7	24705	90.1	24709	92.3	24717	92.6	24730
GR	93	26800	94	26810						
QT	1	13400								
X1	85042	18	20300	20469	1300	800	1109			
CI	-1	66.78	0.035	2.5	2.5	-45	-45			
GR	100	18000	95	19050	90.7	20000	90.8	20100	90.9	20200
GR	89.5	20300	77.6	20327	75.1	20330	74.4	20337	74.8	20345
GR	77.6	20347	81	20430	94.7	20469	93.5	20500	93.3	20600
GR	93.7	20700	94	22600	95	22610				
QT	1	13000								
X1	86257	42	23250	23375	1100	1000	1214			
CI	-1	67.75	0.035	2.5	2.5	-45	-80			
GR	102.1	20000	101.7	20200	101.4	20400	101.8	20600	99.5	20650
GR	99.0	20651	99.4	20670	99.0	20690	99.4	20691	101.2	20800
GR	99.6	21000	98.3	21200	97.5	21400	97	21600	97.1	21800
GR	95.7	22000	93.4	22200	93.7	22400	92.5	22600	92.5	22800
GR	91.9	23000	95.6	23200	96	23250	85.5	23282	84.6	23323
GR	80	23335	82.5	23350	94.3	23375	94.2	23400	94.3	23600
GR	94.4	23800	94.2	24000	94.3	24200	94.2	24400	94.4	24600
GR	94.3	24800	94.1	25000	94.1	25175	92.8	25180	94.6	25192
GR	94.8	25202	95.8	25202						
X1	87471	23	20000	20155	900	1000	1214			
CI	-1	68.72	0.035	2.5	2.5	-45	-80			
GR	105	17650	98.7	19850	99.3	19927	99.6	19928	99.7	19957
GR	99.4	19987	99.6	19988	99.6	19989	99.1	20000	96.8	20001
GR	95.3	20002	94.7	20016	81.5	20055	81.5	20098	94.9	20138
GR	95.2	20153	96.8	20154	99.1	20155	98.7	20227	98.5	20250
GR	96.9	20400	98.0	21300	100.0	21310				
X1	87500				29	29	29			
CI	-1	68.77	0.035	2.5	2.5	-55	-80			
X1	87600				100	100	100			
CI	-1	68.81	0.035	2.5	2.5	-80	-80			
X1	87630				30	30	30			
CI	-1	68.85	0.035	2.5	2.5	-45	-80			
X1	87635				5	5	5			
CI	-1	68.85	0.035	2.5	2.5	-45	-80			
X1	87894	20	20300	20428	195	545	259			
CI	-1	69.10	0.035	2.5	2.5	-45	-80			
GR	105	17950	100	19050	94.1	20000	94.4	20100	95.1	20200
GR	96.9	20300	86.2	20324	85.3	20331	82.4	20334	80	20337
GR	79.4	20347	80.4	20353	82.4	20358	87.1	20370	87.6	20398
GR	96.2	20428	95.9	20528	95.6	20628	98	21700	100	21710
X1	89478	45	22900	23028	1150	1700	1584			
CI	-1	70.61	0.035	2.5	2.5	-45	-80			
GR	100.5	21085	100.6	21095	100.4	21105	99.7	21120	100.4	21125

```
GR  99.7   21200    98.5   21400    97.9   21450    97.3   21451    97.9   21465
GR  97.2   21480    97.9   21481    97.1   21600    95.5   21800    94.7   22000
GR  94.5   22001      95   22040    94.5   22080    94.9   22081    94.8   22200
GR  94.7   22215    94.3   22216    94.7   22230    94.4   22244    94.8   22245
GR  95.2   22400    94.9   22600    94.7   22710    94.3   22711    94.7   22725
GR  94.3   22740    94.7   22741    96.5   22800    96.3   22900    86.9   22929
GR  83.1   22934    81.9   22943    81.2   22962    81.9   22980    87.7   22998
GR  97.6   23028    95.5   23200    95.9   23400     100   24100     101   24150
QT     1   12650
X1 90428      16   20300   20495    1200     700     950
CI    -1   71.51   0.035     2.5     2.5     -45     -80
GR   105   18150      97   20000    96.7   20100    95.5   20200    96.9   20300
GR  83.4   20334    82.2   20367    83.2   20374    91.9   20398    93.4   20470
GR  97.3   20495    96.4   20600      97   20700     100   21800     101   22300
GR   102   22310
QT     1   10500
X1 91378      27   22660   22789     900     800     950
CI    -1   72.41   0.035     2.5     2.5     -40     -70
GR 102.0   21000    99.2   21860    98.9   22000    98.5   22200    98.2   22352
GR  98.0   22366    98.2   22380    98.4   22400    97.1   22600    98.1   22660
GR  88.4   22683    87.8   22722    83.0   22728    82.9   22734    83.0   22740
GR  87.9   22746    87.9   22760    98.0   22789    98.3   22800    98.1   23000
GR  98.5   23200    99.9   23400   99.56   23425   99.41   23435   99.54   23450
GR  99.7   23539   103.0   28000
X1 91575      14   20000   20150     200     200     200
CI    -1   72.60   0.035     2.5     2.5     -40     -70
GR 102.0   17500   101.6   18600    99.4   19552   101.7   20000    88.7   20035
GR  85.3   20062    85.2   20071    85.2   20079    85.1   20079    92.6   20125
GR 101.7   20150   100.3   20911    99.9   21150   103.0   25150
X1 91625                              50      50      50
CI    -1   72.65   0.035     2.5     2.5     -40     -70
X1 91653                              28      28      28
CI    -1   72.67   0.035     2.5     2.5     -40     -70
X1 91703      14   20000   20150      50      50      50
CI    -1   72.72   0.035     2.5     2.5     -40     -70
GR 102.0   17500   101.6   18600    99.4   19552   101.7   20000    88.7   20035
GR  85.3   20062    85.2   20071    85.2   20079    85.1   20079    92.6   20125
GR 101.7   20150   100.3   20911    99.9   21150   103.0   25150
X1 91903                             200     200     200
CI    -1   72.91   0.035     2.5     2.5     -40     -70
X1 93487      21   20200   20329     950    1450    1584
CI    -1   74.41   0.035     2.5     2.5     -40     -70
GR 106.5   18645     105   18960     100   19760    98.5   20000    98.9   20100
GR 100.8   20200    85.0   20241    83.8   20244    83.6   20274    85.2   20294
GR 101.1   20329   103.2   20338   102.6   20370   102.6   20371   102.5   20373
GR 101.3   20436    99.6   20448    99.5   20500     101   21800     102   23100
GR 103.0   25200
EJ



ER
```

6.2.6 - A1.SHD

A1.SHD is the input file for SIDEHYD for the one-weir example and for the upstream weir in the two-weir example. This input has a very simple basin geometry. The hydrograph information in the SIDEHYD base data files is required for consistency with the input format but is not actually used by SAS.

```
       'SIDE1.OUT'  'SIDE1.PLT'
       2
'CHANNEL INVERT AT 66.78 FT.  BOTTOM OF BASIN AT 67.03 FT.'
'BASIN AREA INCREASES WITH ELEVATIONS.'
       1
   45.00   2.5       0.0008   66.78   0.035
   WEIR    17.00   250.0    12.50  6
      20       5       0.05   0.50
       2
    67.03     70.0
    96.98     100.0
 19
   15.00      81.61   6672.0
   15.50      84.11   9319.0
   16.00      87.67   12000.0
   16.50      88.69   12000.0
   17.00      89.16   12000.0
   17.50      89.21   12000.0
   18.00      89.17   12000.0
   18.50      89.13   12000.0
   19.00      89.04   12000.0
   19.50      88.92   12000.0
   20.00      88.58   12000.0
   20.50      88.21   11603.0
   21.00      87.02   9987.0
   21.50      85.68   8640.0
   22.00      83.91   7546.0
   22.50      82.71   6635.0
   23.00      81.67   5867.0
   23.50      80.73   5219.0
   24.00      79.90   4657.0
```

6.2.7 - A1CULV.SHD

A1CULV.SHD is the base input file for SIDEHYD for one set of diversion culverts. This file is the same as A1.H1D in Appendix 6.2.1 except for station numbering and initial estimates of diversion. The lines that have been changed in the file are underlined in this Appendix.

```
       'SIDE1.OUT'  'SIDE1.PLT'
       3
'DIVERSION CULVERT WITH 3 BARRELS.'
'CHANNEL INVERT AT 66.78 FT.  BOTTOM OF BASIN AT 67.03 FT.'
'BASIN AREA INCREASES WITH ELEVATION.'
       1
   45.00   2.5       0.0008   66.78   0.035
 CULV  17.00  3. 12.50 15. 1. 15. 0.012 0.3  0.001
    20       5       0.05   0.10
       2
    67.03     10.0
    96.98     14.0
  19
   15.00      81.61   6672.0
   15.50      84.11   9319.0
   16.00      87.67   9500.0
   16.50      88.69   10000.0
   17.00      89.16   11000.0
   17.50      89.21   12000.0
   18.00      89.17   11000.0
   18.50      89.13   10500.0
   19.00      89.04   10250.0
   19.50      88.92   10100.0
   20.00      88.58   10000.0
   20.50      88.21   9903.0
   21.00      87.02   9500.0
   21.50      85.68   8640.0
   22.00      83.91   7546.0
   22.50      82.71   6635.0
   23.00      81.67   5867.0
   23.50      80.73   5219.0
   24.00      79.90   4657.0
```

6.2.8 - A2.SHD

A2.SHD is an input file for SIDEHYD. This file is the same as A1.SHD except that it includes two drainage culverts.

```
       'SIDE1.OUT'  'SIDE1.PLT'
       3
'SAME AS A1.SHD BUT THIS ONE INCLUDES DRAINAGE CULVERTS.'
'CHANNEL INVERT AT 66.78 FT.  BOTTOM OF BASIN AT 67.03 FT.'
'BASIN AREA INCREASES WITH ELEVATIONS.'
       1
   45.00   2.5       0.0008   66.78   0.035
   WEIR    17.00   250.0    12.50  6
      20       5       0.05   0.50
       2
    67.03     70.0
    96.98     100.0
 19
   15.00      81.61   6672.0
   15.50      84.11   9319.0
   16.00      87.67   12000.0
   16.50      88.69   12000.0
   17.00      89.16   12000.0
   17.50      89.21   12000.0
   18.00      89.17   12000.0
   18.50      89.13   12000.0
   19.00      89.04   12000.0
   19.50      88.92   12000.0
   20.00      88.58   12000.0
   20.50      88.21   11603.0
   21.00      87.02   9987.0
   21.50      85.68   8640.0
   22.00      83.91   7546.0
   22.50      82.71   6635.0
   23.00      81.67   5867.0
   23.50      80.73   5219.0
   24.00      79.90   4657.0
   2
   FLAP     100.  60.  0.  0.  100.  68.  67.
   FLEX    -900.  60.  0.  0.  100.  68.  67.
```

6.2.9 - B1.SHD

B1.SHD is the input file for SIDEHYD for the downstream weir in the two-weir example.

```
       'SIDE1.OUT'  'SIDE1.PLT'
       2
'CHANNEL INVERT AT 66.78 FT.  BOTTOM OF BASIN AT 67.03 FT.'
'BASIN AREA INCREASES WITH ELEVATIONS.'
       1
   45.00   2.5       0.0008   61.12   0.035
 WEIR  17.00   200.0    12.50  6
    20       5       0.05   0.50
       2
    61.50     75.0
    96.98     100.0
 19
   15.00      81.61   6672.0
   15.50      84.11   9319.0
   16.00      87.67   12000.0
   16.50      88.69   12000.0
   17.00      89.16   12000.0
   17.50      89.21   12000.0
   18.00      89.17   12000.0
   18.50      89.13   12000.0
   19.00      89.04   12000.0
   19.50      88.92   12000.0
   20.00      88.58   12000.0
   20.50      88.21   11603.0
   21.00      87.02   9987.0
   21.50      85.68   8640.0
   22.00      83.91   7546.0
   22.50      82.71   6635.0
   23.00      81.67   5867.0
   23.50      80.73   5219.0
   24.00      79.90   4657.0
```

6.2.10 - B1CULV.SHD

B1CULV.SHD is the base input file for SIDEHYD for the downstream set of diversion culverts in the example problem with two sets of diversion culverts. This file is the same as A1CULV.H1D in Appendix 6.2.7 except for the channel invert elevation. The lines that have been changed in the file are underlined in this Appendix.

```
       'SIDE1.OUT'  'SIDE1.PLT'
       3
'DIVERSION CULVERT WITH 3 BARRELS.'
'CHANNEL INVERT AT 61.12 FT.  BOTTOM OF BASIN AT 61.50 FT.'
'BASIN AREA INCREASES WITH ELEVATION.'
       1
   45.00   2.5       0.0008   61.12   0.035
 CULV  17.00  3. 12.50 15. 1. 15. 0.012 0.3  0.001
    20       5       0.05   0.50
       2
    61.50     10.0
    96.98     14.0
 19
   15.00      81.61   6672.0
   15.50      84.11   9319.0
   16.00      87.67   12000.0
   16.50      88.69   12000.0
   17.00      89.16   12000.0
   17.50      89.21   12000.0
   18.00      89.17   12000.0
   18.50      89.13   12000.0
   19.00      89.04   12000.0
   19.50      88.92   12000.0
   20.00      88.58   12000.0
   20.50      88.21   11603.0
   21.00      87.02   9987.0
   21.50      85.68   8640.0
   22.00      83.91   7546.0
   22.50      82.71   6635.0
   23.00      81.67   5867.0
   23.50      80.73   5219.0
   24.00      79.90   4657.0
```